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June 30, 1990

Energy Research Abstracts

Abstracts 27387–29934

Office of Scientific and Technical Information
UNITED STATES DEPARTMENT OF ENERGY

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Energy Research Abstracts

Purpose

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U.S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. Foreign information is obtained through the International Energy Agency's 14-nation Energy Technology Data Exchange, the International Atomic Energy Agency's International Nuclear Information System, or nation-to-nation agreements. **Please note that *ERA* coverage of nonreport literature is limited to that generated by Department of Energy activity.**

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The citations presented in *ERA* are available for online searching as records within the Energy Data Base. The current-year records are available on the Integrated Technical Information System (ITIS). The entire database is available through commercial online vendors.

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Managing Editor, Audrey B. Smith
Technical Editor, Robert W. Rutkowski

Information Sources

The citations presented in *Energy Research Abstracts* are a subset of the worldwide energy information provided to the Office of Scientific and Technical Information (OSTI) through exchange agreements with foreign sources and through exchanges or contracts with U.S. organizations.

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4. **Author(s).** First 10 names in the data record are printed, then "et al." is listed.
5. **Author affiliation.** Only first one is listed, in parentheses after author(s) to which it applies.
6. **Collaboration,** if present.
7. **Corporate author(s)** identifying corporation responsible for document.
8. **Patent assignee and number** for citations of patent documents or applications.
9. **Journal title, volume, and issue** for citations of journal articles.
10. **Date of publication.** If not known, a processing date is in brackets.
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14. **Publisher's name and location** for documents published by a corporate or commercial source.
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16. **Contract or grant number.**
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18. **Conference title, location, and date,** if applicable.
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20. **Sources of availability** from which a copy of the document may be obtained; usually appear as abbreviations. (See information on following page.)
21. **Drop note** or explanatory statement.
22. **Abstract.**
23. **Subject descriptors.** Listed only if no abstract or only a brief statement is included.

Sample Citations

Report

18494 (DOE/ER/40438–T1) **[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report.** Haeberli, W. Phys. VI collaboration. Wisconsin Univ., Madison (USA). Dept. of Physics. [1989]. 12p. Sponsored by DOE Energy Research. DOE Contract FG02-88ER40438. Order Number DE89007246. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper briefly discusses the Wisconsin test facility for storage cells; results of target tests; the new UHV...

Report Analytic

18500 (INIS-SU—69, pp. 30-32) **Transition energies in Ne-like ions. Correlation effects.** Vainshtejn, L.A. AN SSSR, Moscow. Fizicheskij Inst. 1988. (In Russian). In *Experimental and theoretical physics. Collection.* Order Number DE89780060. Available from NTIS (US Sales Only), PC A03/MF A01; INIS.

Kratkie Soobshcheniya po Fizike.; no. 6.

SILVER IONS/energy-level transitions; XENON IONS/energy-level transitions; CORRELATIONS; D STATES; E STATES;...

Journal Article

19055 **A theoretical and experimental investigation of long-pulse, electron-beam-produced rare gas plasmas.** Brake, M.L.; Repetti, T.E. (Energy Beam Interaction Lab. of the Dept. of Nuclear Engineering, Univ. of Michigan, Ann Arbor, MI (US)). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA),* 16(5): 581-589 (Oct 1988). (CONF-881020–: Symposium on radiation physics, Sao Paulo, Brazil, October 3, 1988).

Visible emission spectroscopy (380-650 nm) has been performed on intense, electron beam (1 kA, 300 ns, 300 kV) produced Ar, Kr,...

Patent

18045 **Polarization of fast particle beams by collisional pumping.** Stearns, J.W. To Dept. of Energy, Washington, DC. USA Patent 4,724,117. 9 Feb 1988. Filed date 19 Oct 1984. vp. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

A method for polarizing a fast beam of particles by collisional pumping, comprising the steps of generating a beam...

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Corporate Author Index
The corporation, organization, or institution responsible for the issuance of the document is listed in this index. The entries are arranged alphabetically and provide the title and citation number of the reference. For example, the listing for the "Report" sample citation would appear as shown at right.

Wisconsin Univ., Madison (USA). Dept. of Physics
[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)
Wisconsin Univ., Madison (USA). Lab. of Genetics
Organization of the R chromosome region in maize: Final progress report, June 1, 1983–May 31, 1986, 15:18255 (R;US)

Personal Author Index
Each author's name listed on a document cited in this issue is indexed. An index entry provides title and citation number; for secondary and other names, a cross-reference is given to the primary author name where the full index entry is located.

Hadley, D.L., *See* Lee, A.D., 15:17651
Haeberli, W., [Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)

Subject Index
This index lists the main subject descriptors assigned to each record by indexing professionals. A secondary or qualifier term is used where necessary to describe materials, objects, and processes. Document titles may be enhanced with additional informative phrases where necessary. An excerpt from this index appears at right.

HYDROGEN ISOTOPES
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TRITIUM
Neutron-Rich Isotopes
Study on the strong neutron-rich nuclei of lightest elements, 15:18686 (RA;SU;In Russian)

Contract Number Index
DOE technical reports are listed by contract number. Each entry also provides the primary corporation or organization cited for that contract number. A typical entry is shown.

FG02-88ER40438 **Wisconsin Univ., Madison (USA). Dept. of Physics**
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FG02-88ER60664 **Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)**
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Report Number Index
Technical report literature is indexed by the alphanumerical identifier of the report. Patent documents and conferences are included for convenience. Each entry lists the citation number, the source of availability of the document, an indicator of presence at a GPO depository library, order number, and distribution category. A typical entry is:

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Subject Contents

The subject content of *Energy Research Abstracts* is arranged as shown below. The two-digit and four-digit category numbers printed here illustrate the category number assignment used in the database records.* The following list includes all of the 39 first-level and the 308 second-level categories. Because each issue of *ERA* publishes citations only for those documents announced during the past semimonthly period, some subject categories may not be present in every issue.

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*The numerical subject category scheme is used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's data systems. Categories and definitions for the complete set of six-digit numbers are given in DOE/TIC-4584, *Energy Data Base: Subject Categories and Scope*.

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Energy Research Abstracts

01 COAL, LIGNITE, AND PEAT

Refer also to citation(s) 28628

0103 Preparation

Refer also to citation(s) 27492

27387 (DOE/PC/80523–T11) **Surface and electrochemical studies in coal cleaning: Final report.** Chander, S.; Aplan, F.F.; Briceno, A.; Esposito, M.C.; Pang, J.; Raleigh, C.E. Pennsylvania State Univ., University Park, PA (USA). May 1989. 97p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-85PC80523. Order Number DE90007603. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This final technical report, summarizes the accomplishments of our investigation on surface and electrochemical studies in coal cleaning. A considerable effort was made to characterize coal pyrites in detail. The report is divided into three self-contained portions: flotation studies, characterization of pyrite from coal sources, and electrochemical characterization of pyrite. A variety of reagents were found to be effective for the depression of pyrite during coal flotation: lime, oxidizing agents, reducing agents, polysaccharides, xanthated polysaccharides and dye. Seven pyrite samples purified from coal sources and one ore source pyrite (for comparative purposes) have been characterized by chemical and mineralogical analyses, inherent floatability, apparent specific gravity, surface area, semiconductor type, optical anisotropy, dissolution and oxidation rate. Cyclic voltammetry, steady-state polarization and AC impedance spectroscopy have been used to characterize pyrites from ore and coal sources. These studies show that one reason for difference in the behavior of pyrites is the nature of surface films that form when pyrite oxidizes. 85 refs., 29 figs., 15 tabs.

27388 (NERDDP-EG–88-750) **Dynamic simulation of coal preparation circuits and control systems.** Wiseman, D.M. (and others). National Energy Research, Development and Demonstration Council, Canberra (Australia). Apr 1987. 208p. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

A prototype software system has been developed for the dynamic simulation of coal preparation circuits. This software, termed a dynamic simulator, executes on an IBM PC AT or compatible computer equipped with Professional Graphics standard high resolution colour graphics. Mathematical models of some unit processes in coal preparation (but excluding flotation) are accessed by the simulator. The simulator, which is flexible and easy to use, has been aimed at the coal preparation engineer, rather than the computer specialist. The simulator makes provision for controllers, thus allowing realistic time based simulation of the operation of actual coal preparation circuits.

27389 Evaluation of advanced surface-modification, gravity and electrostatic processes for fine-coal beneficiation. Jacobsen, P.S. (Burns and Roe Service Corp. (US)); Killmeyer, R.P.; Hucko, R.E. pp. 412 of Proceedings of coalprep 89, 6th international exhibition and conference. Industrial Presentations West, Aurora, CO (USA) (1989). (CONF-8905145–: COALPREP '89: 6th international coal preparation exhibition and conference, Lexington, KY (USA), 2-4 May 1989).

The Pittsburgh Energy Technology Center (PETC) recently completed an inter-laboratory test program among six developers of advanced fine-coal-cleaning processes that exploit differences in surface modification (gas mode), specific gravity (aqueous or heavy-liquid mode), or electrostatics (dry mode) to effect separations. These participating organizations received representative samples of three coals. They then ground them to an appropriate size and applied their particular process to each coal with the goal of producing a 2 to 3% ash clean coal with maximum energy recovery. The products were then returned to the PETC for analysis and performance evaluation. This paper discusses the processes involved in this program and presents the results of the beneficiation tests.

27390 A preliminary investigation of fine-coal cleaning via the Micro-Mag Process. Klima, M.S. (Pittsburgh Energy Technology Center, U.S. Dept. of Energy (US)); Marinde, C.P.; Killmeyer, R.P. pp. 412 of Proceedings of coalprep 89, 6th international exhibition and conference. Industrial Presentations West, Aurora, CO (USA) (1989). (CONF-8805145–: Professional development short course program on radioactive waste management for nuclear power reactors and other facilities, Alexandria, VA (USA), 10 May 1988).

The U.S. Department of Energy's Pittsburgh Energy Technology Center recently initiated work on a new fine coal beneficiation technique named the Micro-Mag Process. This process entails the application of cyclones employing a micronized magnetite and water medium to clean fine coal, i.e., less than about 100 microns in size. Unlike commercial plants in which standard grades of magnetite are used, the Micro-Mag Process uses magnetite ground to much finer sizes. Preliminary results on both 50-mm- and 25-mm-diameter cyclones have shown excellent separations of the 100 x 75 micron feed coal fraction, with good separations possible down to 45 microns. Results are given from some preliminary tests involving both cyclones separating under various operating conditions. Testing was also conducted in the area of magnetite recovery. The use of micronized magnetite presents a new set of problems in that the extreme fineness of the particles makes it very difficult to recover them magnetically and to separate them from the coal products. Devices that have been used traditionally to recover magnetite are no longer as effective in capturing micronized magnetite. some initial tests involving the use of a high-gradient magnetic separator for magnetite recovery are discussed.

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Refer also to citation(s) 27438, 27455, 27493, 27505, 27506, 27508, 27515, 27590, 27791, 27910, 28306, 28691

27391 (CONF-891081–, pp. 1-22) **Catalytic two-stage liquefaction (CTSL) process studies on sub-bituminous coal.** Comolli, A.G. (Hydrocarbon Research, Inc., Lawrenceville, NJ (USA)); Johanson, E.S.; Panvelker, S. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC22-88PC88818. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

Following a year's development hiatus, a new three-year contract to study the two-stage, close-coupled, catalytic liquefaction of coal and to scale-up the Catalytic Two-Stage (CTSL) Process, commenced in October 1988. Specifically, the objectives of the programs were to improve the CTSL Process by gaining further knowledge of the two-stage reactions, by finding more effective catalysts, with better hydrogen management, by studying optimum coals and by scale-up of CTSL to a mini-PDU demonstration. The tasks include micro- and bench-scale experiments on catalysts, cleaned coal, solid separation and other process concepts, in addition to modeling and economic studies. To date, in the program, three bench-scale experiments were completed, including some microautoclave modeling, coal and catalyst studies and the subbituminous coal economics were updated. Results of this work are reported herein.

27392 (CONF-891081–, pp. 23-41) **Recent progress at the advanced coal liquefaction facility in the direct liquefaction of coal.** Wesnor, J.D. (Southern Electric International, Inc., Wilsonville, AL (USA)); Pinkston, T.E.; Moore, D.L. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract

AC22-82PC50041. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

The results of the two most recently completed runs, Run 256 and Run 257, and an update of the run currently in progress, Run 258, at the Advanced Coal Liquefaction Facility at the Clean Coal Research Center, Wilsonville, Alabama are presented in this paper. It provides a brief summary of the dynamics of coal liquefaction followed by the actual results of the various runs using different coals and liquefaction techniques and catalysts.

27393 (CONF-891081–, pp. 43-51) **Studies of the initial reactions that occur during direct coal liquefaction.** Stohl, F.V. (Sandia National Labs., Albuquerque, NM (USA)). USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC04-76DP00789. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

The objectives of this work are to identify the types of compounds and process conditions that give rise to retrogressive reactions during preconversion processing. Experiments have been performed to evaluate the impacts of temperature, pressure, catalysts, mineral matter, and hydrogen donors on these reactions. Initial studies have been carried out using dibenzyl ether (DBE) because ether linkages represent one type of bonding believed to be present in coal (1). Previous studies have analyzed the kinetics and mechanism of thermolysis of DBE (2,3) and have also used DBE to study effects of process variables in coal liquefaction (4). Results of thermal reactions with DBE have shown that the main reaction products are toluene, benzaldehyde, benzyl alcohol and benzene (2). In the presence of catalysts such as $ZnCl_2$, the product distributions are more complicated and can contain significant amounts of material with higher molecular weights than DBE (5,6).

27394 (CONF-891081–, pp. 53-73) **A comparative techno-economic analysis of HRI coprocessing, catalytic two-stage liquefaction (CTSL) and H-oil.** Gray, D. (MITRE Corp., McLean, VA (USA)); Tomlinson, G.; El Sawy, A. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

The objective of this presentation is to provide an outline of the methodology that has been developed to allow a comparative technical and economic analysis of coal liquefaction using the HRI CTSL process, coprocessing using the HRI technology, and resid upgrading using the H-Oil process. These three similar technologies have been evaluated on as comparable a basis as possible so that their relative technical and economic merits can be identified. The approach used to perform this analysis also allows sensitivity analyses to be performed with respect to feedstock costs and other significant parameters so that the conditions for economic utilization of coprocessing can be identified.

27395 (CONF-891081–, pp. 75-100) **Bench-scale development of coal/oil co-processing technology.** Duddy, J.E. (Hydrocarbon Research, Inc., Lawrenceville, NJ (USA)); Panvelker, S.V. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC22-87PC79819. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

HRI is conducting bench-scale development of Coal-Oil Co-Processing Technology under US Department of Energy and multi-client international sponsorship. The primary objectives of this research program are to evaluate a number of alternative feedstock combinations in order to understand coal-oil interactions and to identify process improvement routes. To date, a total of five alternative feedstock combinations have been tested in the current bench-scale operations. The following coals have been tested - Texas lignite, New Mexico (McKinley mine), Alberta (Canada), Wyoming (Black Thunder mine), and Taiheiyo (Japan) subbituminous coals, and Westerholt (Germany) bituminous coal. The oils tested are Maya (Mexico) ASB and VSB, Cold Lake (Canada) VSB, and Hondo (California) VSB. In addition, two process improvement runs have been completed - one studying temperature staging and another studying the use of dispersed catalyst and catalyst cascading. The bench-test program has covered a total of 160 run-days. Maya-Texas lignite was the most reactive among the tested feedstock combinations. Maya-Taiheiyo and Hondo-New Mexico combinations showed very low levels of catalyst deactivation. Oil-agglomeration of Forrestburg coal in order to reject ash had very little effect on process performance. A kinetic model has been developed to correlate conversions with process parameters. Future work includes one bench run to study coal-oil interactions. Engineering assessment of the bench-scale results will be made and economic studies performed.

27396 (CONF-891081–, pp. 101-124) **UOP co-processing developments.** Nafis, D.A. (UOP, Des Plaines, IL (USA)); Fullerton, H.E.; Gatsis, J.G.; Miller, M.A. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC22-84PC70002;AC22-87PC79818. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

UOP is currently in the fifth year of a research program sponsored by the U.S. Department of Energy to develop a slurry catalyzed process for co-processing coal and petroleum residuum. This paper summarizes the process by which a slurry of finely ground coal, petroleum residue, and catalysts are mixed with hydrogen, heated, and then directed upflow through a single-stage reactor. This results in the simultaneous conversion of the petroleum residue and coal. The use of a finely divided slurry catalyst provides for continuous intimate contact between the catalyst, hydrogen, slurry components, and reaction products throughout the system, reducing the tendency of reactive thermal fragments of the coal and residue to form coke. The paper goes on to discuss the economic costs and benefits of this processing procedure and the optimization of catalyst concentration for optimum operation.

27397 (CONF-891081–, pp. 125-157) **Stable carbon isotope analysis of coprocessing materials.** Winschel, R.A. (Consolidation Coal Co., Library, PA (USA)); Burke, F.P.; Lancet, M.S. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

This paper was promulgated as part of slide show presentation and follows an outline format. The presentation was to summarize research on methods to quantitatively distinguish coal and petroleum products in coprocessing and demonstrate the application of the method. The advantages of developing a method to quantitatively measure coal-derived and petroleum-derived components is discussed. This knowledge would allow for the optimization of feedstocks and a result in a better understanding of the reaction mechanism of the two feedstocks. It goes on to discuss the accuracy of the carbon isotope methods for determining the proportion of the carbon in the sample derived from coal, or alternately, from petroleum. The results of this research are discussed along with the accuracy gained through these procedures.

27398 (CONF-891081–, pp. 159-172) **Direct liquefaction contractors review meeting.** Ross, D.S. (SRI International, Menlo Park, CA (USA)); McMillen, D.F. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC22-88PC88802. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

The last decade has witnessed a renewed interest in the concept of coprocessing coals and heavy oils. Coprocessing offers the possibility of using coals within the existing infra-structure of oil refineries while eliminating recycling of bottoms, which is associated with most coal liquefaction processes. Both thermal and catalytic processes utilizing a variety of heavy oil feedstocks such as atmospheric and vacuum petroleum residues, and oil sand bitumen have been described. The authors are conducting studies into the effects of hydrothermal pretreatment of coal on the products of

coal/ATB coprocessing. Beneficial effects of hydrothermal pretreatments have previously been reported for pyrolysis and liquefaction of coals. Their objective was to explore if coprocessing also benefited from such pretreatment, and the effects sought were connected to both benefits in oil/asphaltene yields and product quality. This work has been conducted with a sample of Maya ATB, supplied by PETC, samples of a weathered Illinois No. 6 coal (PSOC 1098), and most recently an Argonne Premium Wyodak coal. The most pertinent work has been conducted with the latter coal, and is reported here. Their research program also includes studies with model compounds to help understand the chemical reasons for the observed hydrothermal pretreatment. One possible scenario is that the pretreatment alters the coal structure in a manner that reduces retrogressive reactions during the conversion step. This aspect was pursued by studying the effect of clay minerals, donor solvents, and water on the coupling reactions of catechol. As described below, they observed that while clay minerals promoted the coupling reactions, presence of water mitigated the catalytic effect of clays.

27399 (CONF-891081–, pp. 173-174) **Investigation of the structure and reactions of catalysts and inorganic constituents in coal liquefaction.** Huffman, G.P. (Univ. of Kentucky, Lexington (USA)); Huggins, F.E.; Shah, N. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

The molecular structure and microstructure of several Fe- and Mo-based liquefaction catalysts currently of interest in the research program of the Consortium for Fossil Fuel Liquefaction Science have been investigated by a variety of techniques, including X-ray absorption fine structure (XAFS) spectroscopy, Moessbauer spectroscopy and computer-controlled scanning electron microscopy (CCSEM). The same methods are being used in research aimed at improving their understanding of the role of mineral matter and heteroatoms in coal liquefaction. The molecular structure and microstructure of the catalysts can be directly related to catalytic activity, while the inorganic species and heteroatoms may either behave catalytically or participate in retrograde reactions.

27400 (CONF-891081–, pp. 175-199) **Fundamental studies of retrograde reactions in direct liquefaction.** Serio, M.A. (Advanced Fuel Research, Inc., Hartford, CT (USA)); Solomon, P.R.; Kroo, E.; Bassilakis, R.; Malhotra, R.; McMillen, D. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC22-88PC88814. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

The study of retrograde reactions is being done using an integrated approach using extensive characterization of the liquefaction chemistry of three kinds of systems: (1) model polymers; (2) coal; and (3) modified coals. Most of the proposed processing schemes for improving liquefaction yields involve favoring bond-breaking and radical stabilization reactions over the retrograde reactions. The retrograde reactions are often encountered before liquefaction temperatures are reached. The goal of this program is to elucidate and model the retrograde reaction chemistry in direct coal liquefaction through the application of experimental techniques and theoretical models which have been employed at Advanced Fuel Research (AFR) and SRI International (a subcontractor) to understand and predict coal reaction behavior. The program will necessarily include studies of bond-breaking reactions and solvent effects, since these are intimately related to the retrograde reaction chemistry. The results of the experiments in the proposed program are expected to lead to an improved mechanistic understanding of retrograde reaction mechanisms in liquefaction, that can be used to explore improved process concepts designed to minimize retrograde reactions and, thus, to improve liquefaction yields.

27401 (CONF-891081–, pp. 201-210) **Low temperature liquefaction catalysis: A progress report.** Bockrath, B.; Illig, E.; Keller, M. III; Hough, M. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

Dispersed catalysts have often been used in direct liquefaction, but significant improvements over current practice still seem likely. The full potential of a catalyst can be realized if the temperature of the reaction can be reduced so that the unwanted side reactions leading to coke and gas production that now plague liquefaction processes can be avoided. To reach that ultimate goal, it is desirable to gain a better understanding of the limitations to the performance of catalysts as they are now used. Means will be sought to improve catalyst performance at temperatures below the onset of thermal retrogressive and dehydrogenation reactions.

27402 (CONF-891081–, pp. 211-222) **The DOE [Department of Energy] coal sample bank - Monitoring of coal deterioration.** Davis, A. (Pennsylvania State Univ., University Park (USA)); Glick, D.C.; Mitchell, G.D. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

The prime objective of the authors project Establishment and Maintenance of a Coal Sample Bank and Data Base is to maintain a sample suite of 54 coals for use by DOE researchers and contractors. Data from the 1,400-plus Penn State Coal Data Base can also be made available upon request. The specific objective relative to this presentation has been the monitoring of the condition of the coal samples. Series of repeat analyses of coals and container atmospheres, and the implementation of tests which might identify sample deterioration have been carried out under the subject contract and under sponsorship of other programs. At DOE suggestion some parallel testing has been conducted on coal samples from the Argonne Premium Coal Sample Bank. Alternative methods of sample storage have been compared. The possible significance of sample deterioration to DOE liquefaction research has been considered.

27403 (CONF-891081–, pp. 223-242) **Solubilization of coal by biocatalysts in organic solvents.** Scott, C.D. (Oak Ridge National Lab., TN (USA)); Faison, B.D.; Woodward, C.A. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC05-84OR21400. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

Most of the research on biological solubilization of coal is still associated with direct microbial action on low-ranked coal particulates in an aerobic environment. Under these conditions, the solubilization product is a complex aqueous solution of predominantly aromatic compounds that cover a wide molecular weight range. However, the emphasis of the recent research at Oak Ridge National Laboratory has been on anaerobic solubilization of subbituminous and bituminous coals utilizing both microorganisms and enzymes in vitro. Earlier research has indicated that, under some circumstances, enzymes used in vitro can also affect the solubilization or liquefaction of coal. Such an approach is of great interest since potentially both oxidative and reductive enzymes could be used in either aerobic or anaerobic processes, thus allowing a variety of bioprocessing options. The use of an organic solvent instead of an aqueous medium in conjunction with the enzyme solubilization process may also be possible. Such a system may provide an environment that interacts more effectively with the coal particulates and may generate a nonpolar solubilization product which would have properties that are similar to conventional thermal/chemical coal liquefaction products. The use of isolated enzymes for coal solubilization has been further investigated with the emphasis on enhancing enzyme activity, especially in organic solvents.

27404 (CONF-891081–, pp. 243-249) **Bioprocessing of coal and model compounds.** Bhattacharyya, D. (Univ. of Kentucky, Lexington (USA)); Khalid, A.M.; Hsieh, M.; Kermode, R.I.; Aleem, M.I.H. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract FC22-89PC89851. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In

Direct liquefaction contractors' review meeting. Proceedings. Order Number DE90008423. Available from NTIS, PC A14/MF A01.

Removal of organic sulfur components from coals, oil-water emulsions, and model compounds was studied by using pure cultures and soil isolates developed by enrichment culture technique. Acclimatized, thermophilic (60-70°C) Sulfolobus brierleyi showed 30-40% organic sulfur removal from a 5.8% sulfur coal. Iron precipitation on coal in the form of jarosite and superparamagnetic iron oxyhydroxide was also quantified by Moessbauer spectroscopy. Dibenzothiophene (DBT) is one of the forms of organic sulfur in coal. DBT can be transformed by myriads of soil microorganisms, predominant of which are aerobic, gram negative rods. Pseudomonas and other related types of microorganisms are well known for their DBT degrading activities. Pseudomonas most commonly associated with DBT degradation are Pseudomonas putida, Pseudomonas alcaligenes, and Pseudomonas stutzeri. Bacterial cultures grown on benzoic acid are capable of DBT degradation. Biodegradation studies were conducted with pure Pseudomonas putida cultures and with cultures developed from soil samples collected near oil-wells.

27405 (CONF-891081–, pp. 251-261) **A solid-state NMR study of condensation/retrograde reactions during coal liquefaction.** Miknis, F.P. (Western Research Institute, Laramie, WY (USA)); Zhang, M.; Maciel, G.E. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC22-88PC88813. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

The objectives of this study are to use ^{13}C CP/MAS and ^{1}H CRAMPS NMR techniques to measure changes in the carbon and hydrogen aromaticities in coal and coal-derived products generated by pyrolysis and thermal solubilization of coal in the presence of a hydrogen donor solvent. From these measurements, changes in the aromatic hydrogen-to-carbon ratio will be obtained and used to study condensation/retrograde reactions during coal liquefaction. The study consists of three tasks: (1) develop NMR methods to determine aromatic carbon by CP/MAS and aromatic hydrogen by CRAMPS for low hydrogen-containing organic solids such as coals and coal-derived residues, (2) determine the feasibility of applying the NMR methods to quantitative measurements in coals, and (3) analyze selected samples of coals and coal-derived products provided by the DOE to demonstrate the applicability of the NMR methods to study coal liquefaction.

27406 (CONF-891081–, pp. 263-268) **Kinetics of coal hydrogenation and cracking with Lewis acids using in-situ ESR [Electron Spin Resonance] spectroscopy.** Seehra, M.S. (West Virginia Univ., Morgantown (USA)); Ibrahim, M.M. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract FC22-89PC89851. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

The process of coal cracking and hydrogenation affects N, the density of free radicals. Whereas cracking is expected to increase N, hydrogenation usually lowers N by stabilization of the products of cracking. Many of these free radicals can be detected by ESR (Electron Spin Resonance) spectroscopy. Under the CFFLS program they have developed an apparatus for the in-situ ESR spectroscopy of free radicals in coals for temperatures to 650°C, for studies in vacuum, and in a flowing gas (N_2, H_2), with or without catalysts. The authors also use a TGA (Thermogravimetric Analysis) apparatus to measure weight changes. The objective of this research is to observe coal cracking and hydrogenation of coals in the presence of Lewis acid (e.g. $ZnCl_2$, $ZnBr_2$, ZnI_2) under milder conditions using in-situ ESR spectroscopy and TGA. The results obtained under this program would then be used to liquefy coal under milder conditions, in collaboration with Robert Keogh at the Kentucky Center for Applied Energy Research.

27407 (CONF-891081–, pp. 289-290) **Low temperature depolymerization and liquefaction of premium U.S. coal samples.** Shabtai, J.S. (Univ. of Utah, Salt Lake City (USA)); Zhang Yuan; White, R. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceedings.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

A new procedure for low-temperature coal depolymerization and liquefaction was recently developed. It involves application of three sequential reaction steps in which different types of intercluster linkages in the coal structure are subjected to preferential cleavage, i.e., (1) intercalation of the coal sample with catalytic amounts (3-15%) of $FeCl_3$, followed by mild hydrotreatment (HT) of the coal-$FeCl_3$ intercalate; (2) base-catalyzed depolymerization (BCD) of the product from step 1, under supercritical conditions; and (3) hydroprocessing (HPR) of the depolymerized product obtained from the two consecutive preceding steps, using a sulfided CoMo or RuMo catalyst. Step 1 results in partial depolymerization of the coal by preferential hydrogenolytic cleavage of methylene (and higher alkylene), benzyl etheric, cycloalkyl etheric, and some other reactive linkages in the coal framework, while step 2 is designed to complete the depolymerization of the product from step 1 by base-catalyzed hydrolysis (or alcoholysis) of diaryl etheric, aryl cycloalkyl etheric, thioetheric, and other bridging groups. In step 3 the final depolymerized product is subjected to hydroprocessing (HPR), resulting in exhaustive heteroatom removal and attendant partial ring hydrogenation and C-C hydrogenolysis reactions. The unusual liquefaction efficiency of the overall HT-BCD-HPR procedure was previously demonstrated by the high-yield conversion of several HVB and subbituminous coals into light hydrocarbon oils.

27408 (CONF-891081–, pp. 305-313) **Computer modeling of vitrinite: investigation of reaction pathways and interpretation of spectral data.** Subbaswamy, K.R. (Univ. of Kentucky, Lexington (USA)); Ades, H.F. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract FC22-89PC89851. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceeding.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

The overall goal of the proposed project is to set up a large scale theoretical modeling capability on the University of Kentucky IBM 3090/300E supercomputer which can be used to augment the experimental investigation of coal liquefaction related problems being carried out by the various groups of the Consortium for Fossil Fuel Liquefaction Science. Most of their knowledge of the structure of molecular species in coal and coal products comes from analytical chemical techniques, and through studies involving model compounds. Through years of intense research, fairly detailed molecular models of at least one of the coal macerals, namely vitrinite, have been proposed. Although a single structural model for vitrinite cannot be presented, it is widely accepted that a model proposed by Shinn exhibits most of the features evident from chemical analysis of both coal and the products from liquefaction schemes. This model is used as the prototype to perform electronic calculations and simulations. Semi-empirical, and first-principles methods are used as necessary and appropriate to address different types of problems.

27409 (CONF-891131–, pp. 1-37) **Status of the development of methanol synthesis by the LPMEOH process.** Studer, D.W. (Air Products and Chemicals, Inc., Allentown, PA (USA)); Brown, D.M.; Henderson, J.L.; Hsiung, T.H. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

The Liquid Phase Methanol Project is a viable alternative to traditional gas phase methanol processes and is well suited to coal-derived synthesis gas which is rich in carbon monoxide. This paper describes the progress that has been made at the LaPorte LPMEOH process facility and in the supporting research programs over the last 12 months. The primary purpose of the Process Development Unit (PDU) operating program is to obtain sufficient data to evaluate the LPMEOH technology and allow for a confident move to the next scale of operation. Several process improvements, including elimination of the liquid circulation loop and

operating at high slurry concentrations, have simplified and improved the economics of the process. The productivity of the modified LaPorte PDU was near or above the productivity predicted by a laboratory scale autoclave, and record production rates of 12 tons per day were achieved using a CO-rich (35% H_2, 51% CO, 13% CO_2, 1% N_2) feed gas with a H_2/CO ratio of 0.7 to 1. A number of other coal-derived syngas feedstocks were also evaluated for their methanol potential. Slurry concentrations of up to 50 wt% were activated and operated successfully, and gave higher productivities than previous attempts. Catalyst deactivation rates of less than 0.2%/day were seen over a 120 day life test. Catalyst addition and withdrawal was demonstrated successfully and the PDU ability to load-follow, useful in the co-production of power and methanol, was investigated. This progress represents another step towards commercialization of the LPMEOH process.

27410 (CONF-891131–, pp. 39-58) **Economics of liquid-phase methanol process.** Nizamoff, A.J. (Chem Systems Inc., Tarrytown, NY (USA)). USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

The latest results from the Process Development Unit (PDU) in LaPorte, Texas, are incorporated into the base case IGCC/OTM design. The economics based on the latest design for an IGCC/OTM facility are compared for both the liquid-phase and conventional vapor-phase technologies. The all-methanol design evaluations compare the liquid-phase methanol technology (nominally 5,000 MTPD of methanol production) for both natural gas and coal feeds. These, in turn, are compared with conventional vapor-phase technology for both natural gas and coal-fed facilities.

27411 (CONF-891131–, pp. 59-83) **The OCTAMIX process.** Goehna, H. (LURGI GmbH, Frankfurt (West Germany)); Koenig, P. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

This paper discusses the development of a process for the production of mixed alcohols that can be used as a component for motor fuels. During the ongoing development work for the LURGI Low Pressure Methanol Process a catalyst type was discovered which showed tendency to yield to higher alcohols. Encouraged by the commonly practice of adding so-called oxygenates to gasoline LURGI pursuit to develop a process for production of mixed alcohols in a single synthesis step. To determine the optimal parameters and to prove the quality of the selected catalyst extended pilot plant tests using a water cooled tubular reactor were performed for more than 12,000 hours. Product from the PDU operation was added to gasoline for several test programs in the United States and in Europe.

27412 (CONF-891131–, pp. 103-114) **Modified ferrisilicates for synthesis gas conversion.** Szostak, R. (Georgia Institute of Technology, Atlanta (USA)). USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC22-86PC90007. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

Great strides have been made in the synthesis of silicate-based molecular sieves with the ZSM-5 structure containing catalytically-important elements, such as Fe, Co and Ga. The framework stability of these metal-containing molecular sieves has been found to be limited. However, such instability has been advantageously used in the selective generation of high dispersions of catalytic metal deep within the pores of the constrained-pore zeolite. The catalytic application of the iron-containing materials for synthesis gas conversion has been examined in this phase of the project.

27413 (CONF-891131–, pp. 115-124) **The development of precipitated iron catalysts with improved stability.** Abrevaya, H. (UOP Research Center, Des Plaines, IL (USA)); Targos, W.M.; Cohn, M.J. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC22-87PC79812. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

Precipitated iron catalysts are expected to be used in next-generation slurry-bed reactors for the large-scale production of transportation fuels from synthesis gas. These reactors are expected to operate at higher temperatures and lower ratios of H_2 and CO relative to the Sasol Arge reactor. The utility of iron catalysts has been demonstrated under relatively mild Arge-type conditions but not under more-severe slurry conditions. A major improvement in catalytic stability will be needed to make iron catalysts suitable for slurry operation. This program is aimed at identifying the chemical principles governing the deactivation of precipitated iron catalysts during Fischer-Tropsch synthesis and using these chemical principles in the design of more-stable catalysts. The program has been divided into five major tasks to be conducted over a four-year period: upgrade the existing fixed-bed pilot plant so that it has slurry-bed reactor and Berty-reactor testing capabilities; establish the stability of a state-of-the-art reference-precipitated iron catalyst; construct an iron-catalyst preparation plant and develop a baseline iron catalyst; elucidate the deactivation chemistry for iron catalysts; modify the catalyst chemistry to improve the stability of the catalyst.

27414 (CONF-891131–, pp. 125-155) **Slurry phase Fischer-Tropsch synthesis: Cobalt plus a water-gas-shift catalyst.** Satterfield, C.N. (Massachusetts Institute of Technology, Cambridge (USA)). USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC22-87PC79816. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

The work reported at this time was directed primarily to characterize the carbon number distribution of hydrocarbon products of the Fischer-Tropsch synthesis on a cobalt catalyst over a wide range of industrially-relevant conditions. Particular attention is paid to understanding the effects of process variables on the yield of desired high-molecular weight products. The reactor used in this study behaves as a CSTR and thus provides data at uniform temperature and composition which are easily interpreted. Because incorporation or secondary reactions of alkenes may be responsible for the sensitivity of the product distributions on cobalt to operating conditions, the secondary reactions of synthesized 1-alkenes were also examined. Incorporation has been observed on cobalt in ^{14}C tracer studies by Schulz, Rao and Elstner (1970) and in alkene addition studies by Kibby et al. (1984). This may make the hydrocarbon selectivity on cobalt more sensitive to secondary reactions such as alkene hydrogenation and isomerization.

27415 (CONF-891131–, pp. 157-192) **Promoter and binder/support effects on the activity and selectivity of precipitated iron Fischer-Tropsch catalysts.** Bukur, D.B. (Texas A and M Univ., College Station (USA)); Rosynek, M.P.; Patel, S.A.; Mukesh, D.; Withers, H.P. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC22-85PC80011. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

The effects of potassium and copper promotion, and silica and alumina binders (supports) on activity and selectivity of precipitated iron catalysts for Fischer-Tropsch synthesis (FTS) were studied in a fixed bed reactor. It was found that both potassium and copper increase catalyst activity for FTS and the water-gas-shift (WGS) reaction. Potassium promotion (~0.2 - 1 wt%) results in increase in the average molecular weight of hydrocarbon products, and suppression of secondary reactions (olefin hydrogenation, and isomerization of 1-alkenes to 2-alkenes). Copper promotion (~3 wt%) has similar effect on hydrocarbon distribution, but it enhances slightly the secondary reactions. The activity of doubly promoted (100 Fe/3 Cu/x K, x = 0.2 or 0.5) catalysts was higher than that of singly promoted catalysts and was independent of potassium loading, whereas their selectivity behavior was strongly influenced by their potassium loading. It was found that both the FTS and the WGS activity decreased with increasing support content. Catalyst deactivation rate decreased with catalysts containing 24 and 100 g

of SiO_2 per 100 g of Fe. Secondary reactions increased with increasing silica content. Hydrocarbon selectivities improved (less gaseous hydrocarbons) with the addition of support, except for the catalyst containing 24 SiO_2/100 Fe.

27416 (CONF-891131–, pp. 329-368) **Hydrodynamic studies with Fischer-Tropsch waxes in three-phase bubble columns.** Bukur, D.B. (Texas A and M Univ., College Station (USA)); Patel, S.A.; Daly, J.G. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC22-86PC90012. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

Fischer-Tropsch synthesis reaction represents an important route for indirect coal liquefaction. In recent years, one of the processes which has received a great deal of attention is synthesis in the slurry phase. In this process, synthesis gas is passed through a suspension of small catalyst particles in molten wax. Some of the desirable characteristics of a slurry bubble column reactor are (1) uniform temperature and high rate of heat transfer; (2) high single pass conversion; (3) ability to process CO-rich syngas; (4) high selectivity (i.e., low methane production and high proportion of liquid products); (5) flexibility in operation; and (6) simple construction and low investment cost. This text discusses a number of studies used to investigate the hydrodynamics of bubble columns using molten wax as the liquid medium. However, the findings are relatively inconclusive since considerable differences in results exist amount these studies.

27417 (CONF-891131–, pp. 369-413) **Heat transfer investigations in a slurry bubble column.** Saxena, S.C. (Univ. of Illinois, Chicago (USA)). USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC22-86PC90008. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

This paper provides the results of heat transfer characteristics in two slurry bubble columns equipped with heat transfer probes of different sizes which are configured as a function of the system and operating parameters. The heat transfer coefficient values thus generated for two- and three-phase systems as a function of air velocity, solids concentration and solid particle sizes are compared with the predictions of available correlations and models. These data are analyzed in terms of mathematical models and correlations.

27418 (CONF-891131–, pp. 415-441) **Economics of advanced indirect liquefaction processes.** Tomlinson, G. (MITRE Corp., McLean, VA (USA)); El Sawy, A.; Gray, D. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC04-76DP00789. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

The objectives of this work are to estimate the cost of production of high quality liquid transportation fuels from advanced coal-based indirect liquefaction processes and to determine the economic impact of coproducing electric power using the once-through Fischer-Tropsch concept. This study is an extension of a previous study by the MITRE Corporation and represents the most detailed computer model so far developed for the evaluation of indirect liquefaction.

27419 (CONF-891131–, pp. 443-472) **Integrated coal to transportation liquids study.** Rutkowski, M.D. (Gilbert/Commonwealth, Inc., Reading, PA (USA)); Chen, H.T.; Klett, M.G.; Buchanan, T.L. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

This paper provides a discussion of a study contracted by the U.S. Department of Energy, Office of Coal Conversion, to study if a pattern could be established to direct Fischer-Tropsch liquids production toward economic viability. The overall scope of the study consisted of siting a plant at mine mouth with a throughput of 30,000 tons per day of dry coal. The scope also required that the plant produce all liquid products and useful byproducts, e.g., cogenerated electricity. The proposed design and operation of this facility are discussed.

27420 (DOE/METC–88/6092-Vol.2, pp. 628-637) **Steam conditioning of coal for synfuels production.** Graff, R.A. (The City College CUNY, New York, NY (USA)); Zhou, P.; Brandes, S.D. USDOE Morgantown Energy Technology Center, WV (USA). May 1988. (CONF-880544–: 8. annual gasification and gas stream cleanup systems, Morgantown, WV (USA), 10-13 May 1988). In *Proceedings of the eight annual gasification and gas stream cleanup systems contractors review meeting: Volume 2.* Order Number DE88010254. Available from NTIS, PC A15/MF A01.

The objective of this program is to examine the conditioning of coal in steam as a means for improving yield and quality of condensable hydrocarbon product in mild gasification processes. Three coals will be tested in these studies: Illinois No. 6, Kentucky bituminous, and Mississippi lignite. Task 1 of this project is devoted to a study of the effect of process conditions on steam conditioning. Conditioning pressure will be varied from one to 50 atmospheres and temperature from 300 to 400 C. Effectiveness will be evaluated by extraction of conditioned coal with pyridine at room temperature. The goal is to reduce the severity of the processing conditions. Task 2 is devoted to the design, construction, and operation of a mild gasification test facility for the preparation of larger quantities of condensable product for testing and characterization. This will be comprised of a fluid bed reactor for the rapid heating in steam of 2.5 lbs. of coal per hour. Results are presented from the steam conditioning study on the Mississippi lignite and the Illinois #6 coal. The gasification test facility has been designed and constructed and five shakedown runs have been conducted.

27421 (DOE/METC–88/6098, pp. 8-12) **Mild gasification program overview.** Ghate, M.R. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The goal of the mild gasification program is to develop simple coal conversion schemes. The objectives are to develop processes with a high potential for early commercialization, develop methods that will produce value added products, concentrate on the total system picture, and optimize product quality and quantity for the end-use market. The programs's strategy involves several steps. The first is to target the program to multiple teams of coal producers, process developers, and equipment manufacturers. Another is to select a state-of-the art unit operations with minimum development time. The others are to conduct a market survey, attempt to obtain or penetrate multiple markets for products, optimize the product state according to coal type, and redirect the research program to explore novel concepts. Ten research programs are summarized.

27422 (DOE/METC–89/6099, pp. 95-107) **Copper-based sorbents for hot gas cleanup.** Jalan, V. (ElectroChem, Inc., Woburn, MA (USA)); Desai, M. USDOE Morgantown Energy Technology Center, WV (USA). Oct 1988. In *Gas stream cleanup papers from DOE/METC sponsored contractors review meetings in 1988.* Order Number DE89000901. Available from NTIS, PC A17/MF A01.

The objective of the Phase I research was to establish the feasibility of incorporating copper manganese oxide based sorbents into the Morgantown Energy Technology Center (METC) high temperature regenerable desulfurization process. To meet this objective, a successful sorbent would have to demonstrate high desulfurization capacity, high reactivity (defined as sulfur removal to less than one part per million), efficient and complete regeneration over numerous cycles without loss of surface area or pore structure, the potential for effective integration with coal gas fueled electrical power generation systems (such as the Integrated Gasifier Combined Cycle power plant), and a significant cost advantage over the most promising sorbent systems studied to date. Experimentally,

candidate sorbents were prepared and evaluated for reactivity, capacity, and regenerability. Sorbent systems identified by DOE/METC were tested for comparison. Results are discussed.

27423 (DOE/PC/79935–13) **Numerical simulation of liquid circulation in a bubbly column.** Celik, I.; Wang, Yi-Zun. West Virginia Univ., Morgantown, WV (USA). Dept. of Mechanical and Aerospace Engineering. [1990]. 24p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-87PC79935. (CONF-9006107–1: Symposium on numerical methods for multi-phase flows, Toronto (Canada), 3-9 Jun 1990). Order Number DE90005226. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The gas-liquid flow inside a vertically situated circular, isothermal column reactor has been simulated numerically. The gas-liquid flow is assumed to be in the bubbly flow regime which is characterized by a suspension of discrete air bubbles in a continuous liquid phase such as glycerol water. The mathematical formulation is based on the conservation of mass and momentum principle for the liquid phase. The gas velocity distribution is calculated via an empirically prescribed slip velocity as a function of void fraction. The interface viscous drag forces are prescribed empirically. A profile shape is assumed for the void ratio distribution and the magnitude of it is calculated as part of the solution. The influence of various profile shapes is investigated. Results with the void ratio distribution calculated from the conservation of mass equation for the gas phase are also presented. The mathematical model has been implemented by modifying a readily available computer code for single phase newtonian fluid flows. The numerical discretization is based on a finite volume approach. 21 refs., 3 figs.

27424 (DOE/PC/80534–T1) **Extension of Pitzer corresponding states correlations using new vapor pressure measurements of the n-alkanes C_{10} to C_{28}: Final report for the period ending December 31, 1989.** Morgan, D.L.; Kobayashi, R. Rice Univ., Houston, TX (USA). Dept. of Chemical Engineering. 31 Dec 1989. 107p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-85PC80534. Order Number DE90006785. Available from NTIS, PC A06/MF A01 - OSTI.

Direct vapor pressure measurements of zone-refined n-alkane samples in the carbon number range from C_{10} to C_{28} (decane, dodecane, tetradecane, hexadecane, octadecane, nonadecane, eicosane, docosane, tetracosane, and octacosane) have been obtained. The overall range of the new measurements are from 0.1 to 1400 kPa and from 323 to 588°K with expected accuracies given by (0.00015P + 0.0048)kPa and 0.03°K. The vapor pressure data have been regressed to Wagner-type equations using critical parameters developed. To extend the range of the Wagner equations toward low reduced temperatures, an alternative set of "conformal" equations were constructed using two real-fluid corresponding states principle (CSP) methods. Using n-alkane vapor pressure data in the range from C_1 to C_{36}, the acentric factor ranges of Pitzer-type CSP correlations for vapor pressures and heats of vaporization were extended. In a first approach dubbed "PERT2", a set of "conformal" Wagner equations was generalized by including a second order perturbation term in Pitzer's acentric factor expansion for $\ln(P_r)$. In a second approach, input parameters (P_c,ω) were determined from vapor pressure data for accurate pairs of vapor pressure and heat of vaporization reference equations based on methane and octane (C_1/C_8). Input parameters (T_c,P_c,ω) for n-alkanes have been correlated and tabulated out to C_{36} for both of these approaches. Ratios of the parameters for the two methods can be interpreted in terms of "shape factor" effects. 83 refs., 23 figs., 25 tabs.

27425 (DOE/PC/88815–T1) **Development of a novel approach for coal bioconversion to alcohol fuels.** ARCTECH, Inc., Alexandria, VA (USA). Oct 1989. 70p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88815. Order Number DE90006179. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The goal of this project is to explore the potential for a biological process in which low-rank coals and soluble coal-derived products are converted to short chain alcohols. Initial experiments on the pretreatment of Beulah and Wyodak coals with 20% H_2O_2 resulted in a highly exothermic reaction which was difficult to control. The intense reaction was extremely variable in recovery of the parent coal and duration of the reaction. Approximately 90% of the parent coal carbon for both Beulah and Wyodak coals was recovered following H_2O_2 pretreatment. However, biosolubilization resulted in recovery of only 20% of the added H_2O_2 pretreated coal carbon. Carbon recoveries for the combined H_2O_2 pretreatment and biosolubilization were low for the Beulah (20.2%) and Wyodak (18.5%) coals. Preliminary data on conversion of coal carbon indicate that ethanol can be produced from several untreated parent coals as well as the coal-derived products. The use of methane inhibitors is the key to the development of cultures for biological production of alcohols using coal as the feedstock. Numerous bacterial screening studies were initiated to evaluate environmentally variable natural microorganisms. The major emphasis was on culture development to obtain a suitable consortium or a group of bacterial consortia which could convert a specific coal or coal products to a mixture of alcohols. Methane inhibitors were used to block methanogenesis, and to exclude methanogens from the adapted consortia to force the accumulation of alcohols and other compounds formed during the metabolism of coals or coal-derived products. 5 refs., 2 figs., 18 tabs.

27426 (DOE/PC/88920–T6) **Electrochemistry of Thiobacillus ferrooxidans reactions with pyrite: Technical annual report, September 1989–January 1990.** Pesic, B. Idaho Univ., Moscow, ID (USA). Coll. of Mines and Earth Resources. [1990]. 32p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88920. Order Number DE90009555. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A summary is presented of the accomplished results during the first research contract year. The first stage of research involved the acquisition of equipment and setting up the experimental apparatus. The experimental set up consists of a fermenter and a potentiostat. EG&G PARC potentiostat/galvanostat has been used in this research. The electrochemical research has been done by using a three electrode system: working, counter and reference electrode. Mineral pyrite as the working electrode was used throughout this reporting year. Coal pyrite will be used in the later stages of the research. Among the proposed electrochemical techniques, cyclic voltametry was the only technique used so far. This technique has produced excellent information with regard to the interaction of Thiobacillus ferrooxidans with pyrite. To study the chemical activity of bacteria, the author has developed his own method of study. The method involves growths of bacteria for 5–7 days and their subsequent concentration by filtration. The filter unit is a key factor during separation. 14 refs., 27 figs., 2 tabs.

27427 (NERDDP-EG–88-751) **Catalysts for synthetic liquid fuels.** Bruce, L.A.; Turney, T.W. National Energy Research, Development and Demonstration Council, Canberra (Australia). Dec 1987. 103p. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

Fischer-Tropsch catalysts have been designed, characterized and tested for the selective production of hydrocarbons suitable as synthetic liquid transport fuels from synthesis gas (i.e., by the reduction of carbon monoxide with hydrogen). It was found that hydrocarbons in the middle distillate range, or suitable for conversion to that range, could be produced over several of the new catalyst systems. The various catalysts examined included: (1) synthetic cobalt clays, mainly cobalt chlorites; (2) cobalt hydrotalcites; (3) ruthenium metal supported on rare earth oxides of high surface area; and (4) a novel promoted cobalt catalyst. Active and selective catalysts have been obtained, in each category. With the exception of the clays, reproducibility of catalyst performance has been good. Catalysts in groups 2 and 4 have exhibited very high activity, with long lifetimes and easy regeneration.

27428 (ORNL/FMP–89/2, pp. 179-195) **SNL-1 - Ceramic catalyst materials: Hydrous metal oxide ion-exchange supports for direct coal liquefaction.** Peden, C.H.F. (Sandia National Labs., Albuquerque, NM (USA)); Bunker, B.C.; Martinez, S.L. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

In this semiannual report, we focus on ongoing studies of the local molecular structure of the hydrous titanate materials. Work in

previous reporting periods has shown that loading of active metals on sodium titanate supports by ion exchange leads to much more active and selective catalysts than can be obtained by other loading procedures. In this current reporting period, we describe Raman and ^{17}O NMR results obtained on labeled hydrous titanate materials. In particular, we focus on (1) the effect of altering the Na/Ti stoichiometry in the amorphous powders, and (2) the effect of ion-exchange reactions in acid solution on the distribution of ion-exchange sites in the material.

27429 (PB–90-159781/XAB) **GRI's (Gas Research Institute's) Gasification of Fossil Fuels Subprogram, status report, December 1982.** Gas Research Inst., Chicago, IL (USA). Dec 1982. 54p. (GRI–82/0112). Available from NTIS, PC A04/MF A01.

Activities within GRI's Gasification of Fossil Fuels Subprogram are discussed. The tactical objectives, goals, accomplishments, research strategies, and contract status are described for these project areas: Coal Gasification Processes, Associated Coal Gasification Technology, and In-Situ Coal Gasification Technology.

27430 (PB–90-161084/XAB) **Rocky mountain 1: Underground coal-gasification test, Hanna, Wyoming. Summary report, Volume 1. Appendix. Final report.** Vardaman, M.H. United Engineers and Constructors, Inc., Denver, CO (USA). Stearns-Roger Div. Feb 1989. 527p. Available from NTIS, PC A23/MF A03.

See also PB–90-149030. Portions of this document are not fully legible.

The Rocky Mountain 1 underground coal gasification test was conducted near Hanna, Wyoming during the period January 1986 through March 1988. These appendixes include information supporting Volume I as well as complete data for certain aspects of the gasification phase. These aspects include daily operations reports, raw and corrected process data, thermocouple and Time Domain Reflectometer results, and monitoring well pressure and level data obtained during the gasification phase. Piping and instrumentation diagrams and supplemental informations on the data acquisition system are included.

27431 (PB–90-166109/XAB) **SNG (Substitute Natural Gas) supply research program status report. December 1985.** Gas Research Inst., Chicago, IL (USA). Dec 1985. 77p. (GRI–85/7015). Available from NTIS, PC A05/MF A01.

See also PB–88-181326.

The status (1985) report contains information on activities within GRI's Substitute Natural Gas (SNG) Supply Research Program. Contract summary reports are provided for research projects in the Gasification of Fossil Fuels (Coal Gasification Processes, Associated Coal Gasification Technology, and In Situ Coal Gasification Technology); and Methane From Biomass and Wastes (Methane From Wastes, and Methane From Biomass).

27432 (PB–90-167230/XAB) **GRI's (Gas Research Institute's) gasification from 1983. Fossil Fuels Subprogram status report.** Gas Research Inst., Chicago, IL (USA). Dec 1983. 37p. (GRI–83/0091). Available from NTIS, PC A03/MF A01.

Activities within GRI's Gasification of Fossil Fuels Subprogram are discussed. The tactical objectives, goals, accomplishments, strategies, and contract status are described for these project areas: Coal Gasification Processes, Associated Coal Gasification Technology, and In Situ Coal Gasification Technology.

27433 (PB–90-170655/XAB) **Pressure monitoring and observed effects of mining at the Oak Grove, AL. Coalbed degasification pattern. Report of Investigations/1989.** Oyler, D.C. Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center. 1989. 35p. (BUMINES-RI–9282). Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs.; Library of Congress catalog card No. 89-600248.

The U.S. Bureau of Mines and the United States Steel Corporation evaluated the progress of methane drainage at the Oak Grove, AL, degasification pattern. Coalbed pressures were monitored between December 1981 and November 1985. The effect of the advance of a section of the Oak Grove Mine on changes in gas and water production rates in the pattern was evaluated. Gas production increases were noted in 12 wells; water production decreases were noted in 6. The times of initial influence indicate the presence of a zone of high permeability within the pattern. This zone correlates well in orientation and location with a fracture zone mined through at the mine. The existence of such fracture zones could have a significant effect on productivity of individual coalbed methane wells.

27434 (VTT-TUTK–640) **Purification of tarry gasification gas by catalysts.** Simell, P. (Valtion teknillinen tutkimuskeskus, Espoo (Finland). Polttoainejalostustekniikan laboratorio). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Aug 1989. 145p. (In Finnish). Order Number DE90770748. Available from NTIS (US Sales Only), PC A07/MF A01.

Use alternatives of gas from the gasification of indigenous fuels (peat, wood), containing tar as impurity, can be extended by cleaning the gas by catalysts at a high temperature. In the present study, materials suited for catalytic decomposition of tar were compared and suitable operation conditions were sought for them using a sample gas flow from an industrial-scale gasification process. Test equipment was a tube reactor, into which the sample gas flow was sucked from a sod peat-fired updraft gasifier. The tar content of the gas was about 100 g/m^{3}n. The cracking temperature ranged 700-900 deg C and the retention time of the gas in the catalyst bed 0.1-0.5 s. The order of the studied bed materials to decompose tar was as follows: nickel catalyst - dolomite and limestone - activated aluminium oxide - aluminium silicate - inert material. The most important property of the catalyst was supposed to be the catalyzation of the reaction between intermediate products in thermal cracking of tars, such as light hydrocarbons and carbon and water vapour. Gases light hydrocarbons and thermally cracked tar were formed in the cracking reactions. The hydrogen-carbon monoxide ratio of the cracked gas increased while the activity of the catalyst grew. The tar content of the cracked gas was reduced by increase in the cracking temperature and by prolongation of the retention time. At 900 deg C and 0.3 s retention time the tars and light hydrocarbons were decomposed almost completely to gases by the nickel catalyst. By the dolomite and limestone and aluminium oxide, the tars were decomposed nearly as totally, while the conversion of light hydrocarbons was lower htan that by the nickel. Increase in the water content of the fuel (and product gas) seemed to reduce the tar content and increase the H_2-CO ratio especially when the nickel catalyst was used.

27435 A mechanistic numerical model for coal liquefaction involving hydrogenolysis of strong bonds. Rationalization of interactive effects of solvent aromaticity and hydrogen pressure. Malhotra, R. (SRI International, Menlo Park, CA (USA)); McMillen, D.F. *Energy and Fuels (USA)*, 4(2): 184-193 (Mar-Apr 1990). DOE Contract FG22-84PC70810;FG22-86PC90908.

Experimental results have recently shown that bond scission of coal structures under liquefaction conditions is not limited to spontaneous thermal scission and that hydrogen transfer from a solvent or coal radical (radical hydrogen transfer, or RHT) must now be added to the H-transfer processes that can bring about hydrogenolysis of strong bonds. In this paper, the authors use thermochemical considerations to help delineate the factors that control this competition between (1) RHT, (2) a sequence of elimination of a free H atom followed by addition of the free H atom, and (3) the reverse of radical disproportionation (RRD). These various reactions have been included in a mechanistic numerical model for describing the cleavage of strong (i.e. nonthermolyzable) bonds using dinaphthylmethane as the substrate.

27436 Reaction pathways of model coprocessing systems using molybdenum naphthenate and excess sulfur. Kim, Honggon (Auburn Univ., AL (USA)); Curtis, C.W. *Energy and Fuels (USA)*, 4(2): 206-214 (Mar-Apr 1990). DOE Contract FG22-85PC80502.

The activity and selectivity of catalysts generated in situ from molybdenum naphthenate and excess sulfur for reactions occurring in coal-oil reactions have been examined. The reaction pathways for species representative of those present in coal and petroleum residuum are presented. The MoS_2 catalyst generated in situ promotes partial saturation of the multiring aromatic to hydroaromatic

species but does not promote further saturation of the hydroaromatic or of single-ring alkyl-substituted aromatics.

27437 Interactive chemistry of coal-oil reactions using model systems. Kim, Honggon (Auburn Univ., AL (USA)); Curtis, C.W. *Energy and Fuels (USA),* 4(2): 214-219 (Mar-Apr 1990). DOE Contract FG22-85PC80502.

The interactive chemistry in the coprocessing of coal with petroleum residuum was investigated by using simultaneous reactions of model species representative of those present in coal and petroleum residuum. The catalyst used was a sulfur-insensitive MoS_2 generated in situ from molybdenum naphthenate and excess sulfur. In the thermal reactions, excess sulfur enhanced the extent of hydrogenation of each reactant. Only small interactive effects were observed in the thermal hydrogenation of reactants combined with and without excess sulfur. In the catalytic reactions, organic nitrogen compounds including quinoline, indole, and pyridine severely deactivated the molybdenum sulfide catalyst and inhibited hydrogenation and removal of oxygen and nitrogen.

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Refer also to citation(s) 27387, 27402, 27405, 27408, 27468, 27489

27438 (CONF-891081–, pp. 292-304) **Chemistry of large molecules.** Carlson, G.A. (Sandia National Labs., Albuquerque, NM (USA)). USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC04-76DP00789. From Direct liquefaction contractors' review meeting; Pittsburgh, PA (USA); 2-4 Oct 1989. In *Direct liquefaction contractors' review meeting. Proceeding.* Order Number DE90008423. Available from NTIS, PC A14/MF A01.

Knowledge of coal molecular structure is important in the understanding of coal reactivity. Computer-aided Molecular Design (CAMD) has been used to create and study three-dimensional models of several postulated coal structures (Given, Wiser, Solomon, and Shinn). Using molecular dynamics calculations, the minimum-energy conformations for each structural model have been compared. The physical densities of the minimum-energy conformations have been calculated, and are in agreement with experimental evidence. The frequencies of cross-linking hydrogen bonds have been evaluated for these structures. Finally, the authors have also begun to use CAMD to study model polymeric compounds, whose structure and reactivity may give new insights into coal conversion processes.

27439 (DOE/ER/13537–5) **[Determination of the distribution of hydrogen in coal by FTIR]: Progress report.** Pennsylvania State Univ., University Park, PA (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13537. Order Number DE90009932. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Research continues on the application of FTIR to the structural characterization of coal. Advances in coal solubility and swelling are discussed. 2 figs. (CBS)

27440 (DOE/PC/88912–T4) **Roles of additives and surface control in slurry atomization: Quarterly report.** Tsai, S.C. California State Univ., Long Beach, CA (USA). Mar 1990. 6p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88912. Order Number DE90009840. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This quartery report describes a quantitative correlation between the flow behavior index of a micronized coal slurry and the interparticular van der Waals attraction force a measured by the Hamaker constant. Preliminary results on the effects of interparticular electrostatic repulsion and the liquid viscosity on both the flow behavior and the relative viscosity are also presented. 4 refs., 2 figs., 1 tab.

27441 (DOE/PC/90502–13) **Catalyst accessibility in high volatile bituminous coal: Final report.** Kispert, L.D. Alabama Univ., University, AL (USA). Dept. of Chemistry. Apr 1990. 7p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-86PC90502. Order Number DE90009527. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The EPR technique has been developed in this lab top determine the pore size and number distribution in high volatile bituminous coal using nitroxide spin probes I-XIII of different sizes, shapes and reactivity. We have studied pore size and shape distribution in Mary Lee, Black Creek and Pratt coal from Alabama, the Penn State Coals, PSOC Nos. 271, 137 and 669 as well as PSOC-1354 and PSOC-311 and Argonne Premium Coal Samples (APCS) Nos. 3, 4, 5, 6 and 8. These coals were studied because independent SANS, DRIFT and NMR relaxation studies related to pore size and shape distribution have been recently reported which substantiated our results. ^{14}N and ^{1}H ENDOR spectra have been obtained for the first time from the nitroxide spin probe-doped Argonne Premium Coal Samples (APCS) Nos. 3, 4, 5, 6 and 8. 8 refs., 1 fig.

27442 Effect of sample spinning on detection of ^{13}C NMR in coals. Pruski, M. (Iowa State Univ., Ames (USA)); dela Rosa, L.; Gerstein, B.C. *Energy and Fuels (USA),* 4(2): 160-165 (Mar-Apr 1990). DOE Contract W-7405-ENG-82.

The effects of sample spinning and of Hartmann-Hahn mismatch on detection of ^{13}C for a Pittsburgh No. 8 coal and coronene (as a model compound) by CP/MAS NMR have been studied. The results on the coal were compared with the true ^{13}C intensities under a Bloch decay, indicating that reasonable ^{13}C intensities may be obtained by using cross-polarization and variable contact time. It is suggested that when CP/MAS is used to obtain NMR of ^{13}C in coals, the most reliable results are obtained at low enough static fields such that at moderate spinning speeds production of sidebands and the interference of spinning with the cross-polarization process are avoided.

27443 ^{31}P NMR spectroscopic analysis of labile hydrogen functional groups: Identification with a dithiaphospholane reagent. Lensink, C. (Iowa State Univ., Ames (USA)); Verkade, J.G. *Energy and Fuels (USA),* 4(2): 197-201 (Mar-Apr 1990). DOE Contract W-7405-ENG-82;FG22-88PC88923.

Six chlorophospholanes (2-7) are evaluated as ^{31}P NMR tagging reagents for labile hydrogen functional groups known to be present in coal materials. In this series, 2 is demonstrated to be best for resolving the ^{31}P NMR chemical shifts of a variety of model compounds within a given functional group class, as well as for the separation of the shift ranges among the various classes.

27444 Density and viscosity of tetralin and trans-decalin. Goncalves, F.A. (Univ. of Maryland, College Park (USA)); Hamano, K.; Sengers, J.V. *International Journal of Thermophysics (USA),* 10(4): 845-856 (Jul 1989).

New measurements are reported for the density and viscosity of tetralin and trans-decalin. The density was determined from room temperature to 60°C for tetralin and to 95°C for trans-decalin. The kinematic viscosity was measured up to temperatures slightly above 100°C. Their results improve upon the values recommended by the American Petroleum Institute for these liquids.

0108 Waste Management

Refer also to citation(s) 27489, 27494, 27496, 27497, 27498, 27499, 27500, 27501, 27503, 27512, 29030

27445 (CTH-IE-A–89-180) **Emissions from a circulating fluidized bed boiler 2.** Mjoernell, M. (Goetaverken Energy AB, Goeteborg (SE)); Hallstroem, C.; Karlsson, M.; Leckner, B. Chalmers Univ. of Tech., Goeteborg (Sweden). Dept. of Energy Conversion. Aug 1989. 78p. Order Number DE90770876. Available from NTIS (US Sales Only), PC A05/MF A01.

A comprehensive study of the emissions from a 40 MW_{th} circulating fluidized bed boiler has been carried out. The possibilities to decrease the emissions of sulphur dioxide with limestone addition, and to reduce nitrogen oxides, including nitrous oxide, have been investigated. Special tests have been devoted to the influence of limestone addition on nitrogen oxides emission, the effect of fly-ash recirculation, and thermal reduction of nitric oxide by injection of additives to the flue gas. The results show that a plant of this kind can satisfy the recently accepted Swedish guidelines for emissions. In addition, there is a region for further improvements when more knowledge of this subject has been acquired. (40 figs., 6 tables).

27446 (PB–90-160748/XAB) **Spray-dryer spent-sorbent hazardous-waste fixating and cementitious properties.** Schultz, T.D.; Berger, R.L.; Fishbein, K. Illinois Univ., Urbana, IL (USA). Mar 1989. 114p. Available from NTIS, PC A06/MF A01.

The primary purpose of the project was to develop a use for the spent sorbent from a spray dryer flue gas desulfurization system. In addition to spent sorbent, fly ash was included in the utilization schemes because it is a byproduct of coal combustion and because it is a pozzolan. It would be helpful to find uses for these two substances and thus decrease the amount of land needed for their disposal and help offset the costs of flue gas desulfurization.

27447 (PB–90-161100/XAB) **Evaluation of methods for handling and burial of toxic strip-mine spoil. Final report.** Robins and Associates, Harrisburg, PA (USA). 29 Apr 1982. 107p. Available from NTIS, PC A06/MF A01.

Surface mining practices confirm few established procedures exist for toxic spoils handling. Lack of any proven systematic approach is a hindrance to the surface mining industry and the regulatory bodies that govern it. Development of current methods of toxic spoils handling resulted mostly from trial and error efforts of individual mining operators. Present measures are less efficient than they might be. Factors affecting efficiency include limited data and poor interaction among operators and research institutions and regulatory agencies as well as the absence of any comprehensive monitoring program to adequately assess results.

27448 (PB–90-167354/XAB) **Strength and consolidation characteristics of fine-coal refuse. Annual report.** Huang, Y.H.; Li, J.; Weeratunga, G. Kentucky Univ., Lexington, KY (USA). Dept. of Civil Engineering. Apr 1987. 127p. Available from NTIS, PC A07/MF A01.

The study is part of a research project entitled Strength and Consolidation Characteristics of Coal Refuse for Design and Construction of Disposal Facilities supported by the Office of Surface Mining, Department of Interior. Information presented in the report will be used for the design and construction of disposal facilities. Fine coal refuse, which is the waste product washing through a no. 28 (0.589 mm) sieve, can be disposed in two different forms: solid or liquid. To be disposed as a solid, the moisture content of fine refuse must be reduced. The investigation on the undrained shear strength of partially saturated fine refuse proceeded in the same manner as that of the combined refuse, and similar equations and charts were developed. These equations and charts can also be used to estimate the undrained shear strength of consolidated fine refuse when disposed as a slurry. To be disposed as a slurry, the fine refuse must be pumped into a lagoon or behind a dam and let settle.

27449 (PB–90-859760/XAB) **Magnetic separation of materials. October 1976-November 1989 (A Bibliography from the COMPENDEX data base). Report for October 1976-November 1989.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 97p. Available from NTISPC N01/MF N01.

Supersedes PB–85-872653.

This bibliography contains citations concerning the design, development, and testing of equipment which uses magnetism as a means of separating and purifying ores and minerals. This technology is used extensively in cleaning fossil fuels, separating fly ash constituents, mineral separations, beneficiation of ores, and other ore processing systems. The articles presented describe various operating systems, separating techniques and variables, and high-gradient magnetic separation which can be used with certain metal oxides and other paramagnetic materials. (This updated bibliography contains 225 citations, 96 of which are new entries to the previous edition.)

27450 (STEV-FBT–89-48) **TGA determination of the sulphur dioxide absorption capacity of some Spanish limestones.** Ghardashkhani, S. (Chalmers Univ. of Tech., Goeteborg (SE). Dept. of Inorganic Chemistry); Jaeglid, U.; Lindqvist, O.; Pettersson, G. Statens Energiverk, Stockholm (Sweden); Chalmers Univ. of Tech. and Univ. of Goeteborg, Goeteborg (Sweden). Dept. of Inorganic Chemistry. 1989. 55p. Project STEV-276-363. (CTH-OOK–89-04). Order Number DE90770792. Available from NTIS (US Sales Only), PC A04/MF A01.

The objective of this study was to determine the sulphur dioxide absorption characteristics of some Spanish limestones. Samples from four mines were supplied by the Spanish electricity company ENDESA and two samples from another location (Carla and Doris) were investigated for comparison. Altogether 28 samples from six different mines were analysed. The different limestone mines were selected by ENDESA in cooperation with ABB Carbon. The latter company is converting a conventional coal power plant to a pressurized fluidized bed combustor (PFBC) for ENDESA. The PFBC unit will utilize addition of limestone for effective reduction of sulphur dioxide emissions. The investigated limestones are from mines in the province Aragonia in the north-eastern part of Spain, and were formed during the Jura period, i.e. about 150 million years ago. All samples from Mines 1-4 selected by ENDESA are taken from surface layers. The Doris and Carla samples are taken from the limestone layers close to the ABB Carbon PFBC pilot plant. Limestone from Mine 2 is ranked as the best sorbent for different FB techniques. For FB concepts with short residence time and small sorbent particle size, material from Mine 1, Mine 4 and the Carla mine are ranked nearly as effective as those of Mine 2. The results from Mine 3 and the Doris mine are more scattered. The investigation of six samples, e.g. two fractions and three locations from each mine, was made to get a representative picture of the reaction capacity with sulphur. However, analysis with a variance component model indicated that even more samples were needed to get a statistically significant difference of the six mines investigated. (36 figs., 2 tabs.).

27451 (STEV-FGT–90-3) **Sulphur capture in a 16 MW fluidized bed boiler - decomposition of $CaSO_4$ at high temperatures.** Lyngfelt, A. (Chalmers Univ. of Tech., Goeteborg (Sweden). Dept. of Energy Conversion). Statens Energiverk, Stockholm (Sweden); Chalmers Univ. of Tech., Goeteborg (Sweden). Dept. of Energy Conversion. 1988. 38p. Project STEV-276-201. (CTH-IE-A–88-169). Order Number DE90770853. Available from NTIS (US Sales Only), PC A03/MF A01.

Sulphur capture by lime was studied in a 16 MW fluidised bed boiler located at Chalmers University of Technology. The desulphurization process, i.e. the addition of limestone which is calcined and sulphated, results in an accumulation of $CaSO_4$ in the bed. The $CaSO_4$ is shown to be decomposed to CaO with subsequent release of SO_2 at temperatures above 880-890 deg C, and at an excess air ratio of 1.4. After an increase in temperature to 930 deg C the amount of sulphur leaving the boiler as SO_2 was more than double the amount of sulphur added to the boiler in the form of fuel-sulphur. In addition to the studies of SO_2 emission, data were obtained concerning NO emission, composition of bed material, composition of fly-ash and fly-ash mass flow. From these data combustion efficiency, calcium mass balance and calcium residence times were derived. Also it was found that limestone addition involved a decrease in the emission of NO, indicating that the sorbent particles were active in the reduction of NO. As the limestone addition was stopped a further decrease in the NO emission was noted, suggesting that it is not CaO but rather $CaSO_4$, or possibly CaS, that is active in the reduction. (author) (37 figs.).

27452 Heat of hydration and characterization of reaction products of adiabatically cured fly ash and slag mixtures. Kaushal, S. (Materials Research Lab., The Pennsylvania State Univ., University Park, PA (US)); Roy, D.M.; Licastro, P.H. pp. 301 of Fly ash and coal conversion by-products: Characterization, utilization and disposal V. Hemmings, R.T.; Berry, E.E.; McCarthy, G.J.; Glasser, F.P. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8812113–: 4. symposium on fly ash and coal conversion by-products: characterization, utilization and disposal, Boston, MA (USA), 1-3 Dec 1988).

The hydration of cementitious materials is an exothermic process which results in significant temperature increases in large masses of these materials. The thermal environment under these conditions is nearly adiabatic. The authors report the heat of hydration of cementitious aluminosilicate blend materials incorporating fly ash and granulated blast-furnace slag calculated from the adiabatic temperature rise. Additional reaction of siliceous fly ash with alkaline solutions results in the formation of zeolitic reaction products. Studies were carried out to characterize the hydration products by

X-ray diffraction and through analysis of solutions. In addition, zeolitic reaction products were prepared by reacting the pure Class F fly ash at 90°C with NaOH and different anions. This study has implications for general thermal properties of hydrating cementitious materials, and for cost-effective immobilization of radioactive and chemical waste cations and anions.

27453 By-product sulfur from the stabilization of coal solid wastes. Gokhale, A.J. (Dept. of Chemical Engineering, Texas A and M Univ., College Station, TX (US)); Burnet, G. pp. 301 of Fly ash and coal conversion by-products: Characterization, utilization and disposal V. Hemmings, R.T.; Berry, E.E.; McCarthy, G.J.; Glasser, F.P. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-82. (CONF-8812113–: 4. symposium on fly ash and coal conversion by-products: characterization, utilization and disposal, Boston, MA (USA), 1-3 Dec 1988).

The authors discuss a stabilization process for coal cleaning and coal combustion-related wastes that uses the energy derived from the fuel contained in the coal cleaning wastes. The wastes are pulverized, when necessary, formed into granules in a rotary pan agglomerator, and then fired to a sintering temperature. The result is a readily disposable product that is highly resistant to environmental degradation. Granules of refuse only, and of refuse/fly ash and refuse/FDG sludge mixtures have been investigated. About 90 wt% of the sulfur in the refuse/sludge mixtures is evolved as SO_2 during the combustion/sintering portion of the process. Studies using a micro-reactor system have shown the generation of SO_2 to be a function of temperature and to parallel the decomposition of the sulfur-containing compounds present. Based on laboratory test, SO_2 concentrations of 4-8 vol% are predicted in the SO_2-rich offgases. By-product sulfur recovery from the off-gases appears practical and attractive using current technology that is proven and well established.

27454 Mineralogy of weathered flue gas desulfurization sludges. Mattigod, S.V. (Battelle, Pacific Northwest, Richland, WA (US)); Rai, D.; Zachara, J.M.; Amonette, J.E. pp. 301 of Fly ash and coal conversion by-products: Characterization, utilization and disposal V. Hemmings, R.T.; Berry, E.E.; McCarthy, G.J.; Glasser, F.P. Materials Research Society, Pittsburgh, PA (USA) (1989). Contract RP2484-08. (CONF-8812113–: 4. symposium on fly ash and coal conversion by-products: characterization, utilization and disposal, Boston, MA (USA), 1-3 Dec 1988).

The authors report the results of samples of flue gas desulfurization sludge characterized chemically and mineralogically. X-ray diffraction analysis indicated that the major crystalline components in the sludge samples were calcite, hannebachite, gypsum, and quartz. Identification of major compounds was confirmed through morphological and chemical analyses using scanning electron microscopy with energy dispersive X-ray analysis. In a related study, equilibrium solubility measurements of these samples corresponded with known solubilities of calcite, hannebachite, and gypsum.

27455 Mineralogy of the residues from an underground coal gasification test. McCarthy, G. (Dept. of Chemistry and Geology, North Dakota State Univ., Fargo ND (US)); Stevenson, R.J.; Oliver, R.L. pp. 301 of Fly ash and coal conversion by-products: Characterization, utilization and disposal V. Hemmings, R.T.; Berry, E.E.; McCarthy, G.J.; Glasser, F.P. Materials Research Society, Pittsburgh, PA (USA) ([1990]). (CONF-8812113–: 4. symposium on fly ash and coal conversion by-products: characterization, utilization and disposal, Boston, MA (USA), 1-3 Dec 1988).

The authors report the detailed mineralogical characterization by X-ray diffraction, scanning electron microscopy and electron microprobe analysis performed on a suite of residues and on three samples of unaltered overburden excavated from a 1983 underground coal gasification (UCG) test conducted at a mine site near Centralia, Washington. The residues were classified into nine zones based on their appearance and location in the burn cavity. Because they were isochemical with the overburden, six of these zones could be identified as altered overburden and proved to be particularly useful for correlations of mineralogy with the temperature and redox atmosphere prevailing in these materials during the UCG process. A previously unrecognized, moderate temperature reaction between reduced iron phases and clay minerals to form an Al-rich hercynite-spinel solid solution (Al-spinel), $(Fe,Mg)Al_2O_4$, was identified. This reaction is a precursor to the well-known formation of Fe-cordierite, $(Mg,Fe)_2Al_4Si_5O_{18}$ from SiO_2 and the Al-spinel at higher temperatures. The mineralogies of altered overburden were analogous to high-temperature, low pressure, metamorphic rocks of the sanidinite facies, and to thermally altered rocks from natural coal combustion.

0109 Environmental Aspects

Refer also to citation(s) 27447, 27946, 28356, 28357, 28984, 29039

27456 (PB–90-153123/XAB) **Evaluation of wildlife mitigation practices at western coal operations. Final report.** Comer, R.D.; Stoecker, R.E.; Thompson, R.W. Thorne Ecological Inst., Boulder, CO (USA). Nov 1984. 100p. Available from NTIS, PC A05/MF A01.

Portions of this document are not fully legible.

The relationship between habitat features and wildlife communities on reclaimed coal-mined surfaces was studied at 4 surface mines in Wyoming and Montana during 1983. Multiple linear regression analysis identified relations between 28 predictor and 17 response variables for big game, small mammals, lagomorphs, galliformes, and breeding birds. Big game use of reclaimed surfaces was inversely related to distance to native habitat and directly related to rock piles and surface shrub cover. Ponds, rock piles, adjacent habitat complexity, vegetation complexity, total vegetation cover, and forbs were important to small mammal richness and abundance. Cottontails were positively correlated with rock pile density and surface topography and negatively correlated with grass cover and distance to native habitat. Jackrabbits were more abundant on undulating surfaces containing large rockpiles. Grass and shrub cover were important to galliformes. Breeding bird richness was greatest on surfaces with trees, within 600 m of water sources, and on surfaces proximal to high quality undisturbed habitats.

27457 (PB–90-157801/XAB) **Effect of controlled overburden placement on mine-soil properties and the growth of loblolly pine. Final report.** Amos, D.F.; Burger, J.A.; Daniels, W.L. Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (USA). 1 Jul 1984. 90p. Available from NTIS, PC A05/MF A01.

Portions of this document are not fully legible.

Natural topsoil in Southwest Virginia is often thin, rocky, acidic and infertile. As a result, rock spoil topsoil substitutes are commonly used. In order to evaluate the first year effects of rock type and surface treatments of topsoil, sawdust and sewage sludge on revegetation, a controlled overburden placement experiment was designed. The effects of rock type, surface treatments, and mycorrhizal inoculation (Pisolithus tinctorius) on the survival and growth of bare-root loblolly, Virginia and white pine seedlings was evaluated in the experimental plots, and in a separate greenhouse study. In the greenhouse experiment, seedling germination was higher on siltstone spoil, but growth and fertilizer response was superior on sandstone spoil. White pine was the only species to show growth response to PT inoculation in the greenhouse. It is felt that careful overburden selection and placement, coupled with the proper surface treatments, can create a hard rock derived mine soil which is equal to a mixture of A, E, B, C and CR soil horizons in first year productivity.

27458 (PB–90-158395/XAB) **Economic evaluations of OSM (Office of Surface Mining) agronomic and biological sciences regulations (prime farmlands). Final report.** Hittman Associates, Inc., Columbia, MD (USA). Jan 1982. 74p. Available from NTIS, PC A04/MF A01.

The report presents an economic evaluation of the potential costs and benefits and the potential effects on small business entities associated with implementing rule-making changes in sections of the permanent regulatory program issued under the Surface Mining Control and Reclamation Act of 1977 including: Prime Farmland: Special Requirements; Soil Removal; Soil Stockpiling; Revegetation and Restoration of Soil Productivity. The current set of regulations including all changes that were codified as of February 1, 1981. In order to obtain the incremental costs and benefits for each of the above scenarios, the base case condition was established against which the impact was measured.

27459 (PB–90-158411/XAB) **Technical guides on use of reference areas and technical standards for evaluating surface-mine revegetation in OSM (Office of Surface Mining), Regions 1 and 2.** Farmer, R.E.; Rennie, J.C.; Scanlon, D.H.; Zarger, T.G. Tennessee Valley Authority, Norris, TN (USA). Div. of Land and Forest Resources. 1981. 90p. (TVA/ONR/LFR–81/12). Available from NTIS, PC A05/MF A01.

The handbook was prepared to assist mine operators and regulatory authorities in evaluating success of reclamation vegetation in the Appalachian coalfields. Section 1 is devoted to pastureland and other agronomic and horticultural crops, postmining land uses for which the use of both the reference area and technical standards approaches to productivity are suitable. Section 2 deals with considerations relative to the use of reference areas in evaluating reclamation for forestry, wildlife management, and watershed protection and suggests technical standards be adopted as the regulatory approach. Section 3 describes a system for evaluating revegetation where the postmining land use is forestry and where standards (woody plants per acre and ground cover percentage) are fixed by regulation.

27460 (PB–90-160714/XAB) **Engineering-scale demonstration of thermal desorption technology for manufactured gas plant site soils.** Helsel, R.; Alperin, E.; Groen, A. IT Corp., Knoxville, TN (USA). Nov 1989. 101p. Available from NTIS, PC A06/MF A01.

Portions of this document are not fully legible.

As part of a program to evaluate and develop technologies that are applicable for remediation of contaminated soils at manufactured gas plant (MGP) sites, pilot plant tests of a thermal desorption treatment technology were performed. Coal-tar-contaminated soil samples from three MGP sites were characterized, and bench-scale treatability tests were performed to establish treatment conditions to use for the pilot tests. Residual concentrations of polycyclic aromatic hydrocarbons (PAHs) were analyzed for all treated soil samples to determine treatment performance of the bench-scale and pilot plant test systems. Temperature, residence time, and soil type all had a significant effect on treatment efficiency. Reasonable agreement was found among results from the static, batch, bench-scale test apparatus and the dynamic, continuous pilot plant. The report presents the test results and describes the experimental procedures.

27461 (PB–90-161357/XAB) **Comparison of the permitting processes of SMCRA and the Corps of Engineers concerning the regulation of coal-dredging activities. Final draft report.** Neville, A.; Sullivan, J.K. Smithsonian Institution, Washington, DC (USA). 24 Apr 1984. 35p. Available from NTIS, PC A03/MF A01.

The study describes and identifies how Corps of Engineers (COE) permits are regulating coal-dredging activities and determines what opportunities exist for the formulation of a single coal-dredging permit that satisfies both Surface Mining Control and Reclamation Act (SMCRA) and COE responsibilities. The first step in the process is to compare the existing COE permit process with SMCRA's mandate and to identify the principal similarities and differences. Following the analysis, a coordinated permitting process will be proposed which will address gaps in the two programs and fulfill their respective regulatory requirements.

27462 (PB–90-162488/XAB) **Summary of Soil Conservation Service activities related to surface coal mining and state regulatory authorities (1984).** Slusher (David), Lexington, MO (USA). 6 Nov 1989. 163p. Available from NTIS, PC A08/MF A01.

A summary of Soil Conservation Service activities related to surface coal mining and state regulatory authorities is presented.

27463 (PB–90-162652/XAB) **Superfund Record of Decision (EPA Region 5): Cliff/Dow Dump, Marquette, MI. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 27 Sep 1989. 104p. (EPA/ROD/R–05-89/100). Available from NTIS, PC A06/MF A01.

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The municipally owned 2-acre Cliff/Dow Dump site is in a wooded recreational area adjacent to the Dead River in Marquette, Michigan. From 1954 until the early 1960s wastes generated by the Cliffs-Dow Chemical Company's charcoal manufacturing plant were deposited at the site. The wastes, which included tar and tar-contaminated fill materials, were deposited to fill a small bog depression. The 200 cubic yards of exposed tar deposits are the primary source of contamination in the soil; however, the remaining 9,400 cubic yards of fill material containing charcoal and wood intermingled with approximately 200 cubic yards of tar, are also a contamination source. Results of pilot studies indicate that ground water is undergoing in situ biodegradation as it flows downgradient of the fill and poses no risk to human health or the environment. The primary contaminants of concern affecting the soil are VOCs including benzene, toluene, PCE, and xylenes; and other organics including PAHs and phenol.

27464 (PB–90-162686/XAB) **Superfund Record of Decision (EPA Region 8): Burlington Northern (Somerset Plant), Somers, MT. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 27 Sep 1989. 126p. (EPA/ROD/R–08-89/023). Available from NTIS, PC A07/MF A01.

Portions of this document are not fully legible.

The 80-acre Burlington Northern (Somers Plant) site is a former railroad tie treatment facility in Somers, Flathead County, Montana. Burlington Northern operated the treatment plant from 1901 to 1986 and generated wastewater primarily consisting of stream condensate containing zinc chloride and creosote, which was discharged to a lagoon south of the treatment building. Overflow from the lagoon flowed through an open drainage ditch to a pond which formed in a swamp area adjacent to the ditch, and eventually into the lake. Contaminated soil and sediment areas in addition to the drainage ditch, swamp pond, and lagoon include a drippage area along the railroad tracks where treated ties were removed from the treatment building, a slough area where treated ties were stored, and a beach area extending into Flathead Lake. Ground water in the vicinity of the lagoon and the swamp pond is also contaminated. The primary contaminants of concern affecting the soil, sediment, and ground water are organics including creosote constituents such as PAHs and phenols, and metals including zinc.

27465 (PB–90-165176/XAB) **Fiscal year 1988 program report: Pennsylvania Center for Water Resources Research.** McDonnell, A.J. Pennsylvania State Univ., University Park, PA (USA). Environmental Resources Research Inst. Aug 1989. 34p. Available from NTIS, PC A03/MF A01.

See also report for 1987, PB–89-123475.

Three projects and a program of technology transfer were conducted under the Pennsylvania Fiscal Year 1988 State Water Resources Research Grants Program (PL 98-242, Sect. 104). In a completed study focused on the protection of water supplies, mature slow sand filters were found to remove 100 percent of Cryptosporidium and Giardia cysts. A site specific study examined the behavior of sedimentary iron and manganese in an acid mine drainage wetland system. A study was initiated to link a comprehensive non-point source model, AGNPS with current GIS technology to enhance the models' utility for evaluating regional water quality problems related to non-point source agricultural pollution.

27466 (PB–90-167750/XAB) **Concepts for protection against catastrophic events from coal mining. Final report.** Baker, E.T.; Kern, J.R.; Sparks, J.P.; Stingelin, R.W. Resource Technologies Corp., State College, PA (USA). 6 Nov 1989. 307p. Available from NTIS, PC A14/MF A02.

The report identifies hazards which may result from coal mining and identifies associated preventive, mitigative, and recovery adjustments. It documents an analysis of the alternatives available to provide protection against catastrophic events. The environmental risks addressed are those that occur beyond the period of time when normal surface and underground mining and reclamation operations have been completed. Residual hazards investigated include: ground water pollution, loss of aquifer, surface water pollution, subsidence, landslides, mine fires, impoundment failures, and mine seal failures. Hazard adjustments investigated include: land use management programs, recovery and restoration programs, insurance programs, special trust funds, bonds and guarantees, disaster assistance programs, regulatory requirements, and litigative approaches. Effective regulation of mine operations to prevent

the creation of hazard including the control of final land-form was found to be the most efficient adjustment. The report includes a comprehensive 30-page annotated bibliography of hazards and related adjustments.

0110 Reserves, Geology, and Exploration

27467 (NERDDP-EG–88-739) **Bowen Basin - stress, structure and mining conditions: assessment for mine planning.** Mallett, C.W. (and others). National Energy Research, Development and Demonstration Council, Canberra (Australia). Dec 1987. 233p. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

Mining conditions in the Bowen Basin are significantly influenced by geological structures. The style and intensity of deformation encountered in coal measures is directly correlated to the regional tectonics. Regional features affecting local coal mine structure are identified from satellite imagery, geological and geophysical mapping. Northeast to southwest oriented structural corridors are recognised as a fundamental basin framework feature. Difficult mining conditions are associated with these corridors and northwest to southeast low angle thrusts. Structural models are presented for representative mines in the basin. Detailed fault geometry for specific cases is predictable from partial exposures by comparison with typical 'models' derived for each site. Models are based on mine geological databases, with mapping of key areas, and provide a description and classification of faults, a three dimensional model of the fault systems, and the sequence of tectonic events. In situ maximum horizontal stress levels normally range from 4 to 12 mPa for depths 60 to 250 metres with its orientation usually paralleling strike of the coal measures. These values are typical for eastern Australia and high stress related mining difficulties are only found locally, associated with fault zones and structural corridors.

27468 (PB–90-159054/XAB) **Quality assessment of strippable coals in New Mexico, Year 3, Phase 2. Menefee, Crevasse Canyon, and Moreno Hill Formation coals in the San Juan Basin and salt lake coal field. Report for 30 September 1987-30 November 1988.** New Mexico Inst. of Mining and Technology, Socorro, NM (USA). Nov 1989. 113p. Available from NTIS, PC A06/MF A01.

See also PB–87-216156.

Drill sites spaced, when possible, about 2 miles apart along the down-dip edge of strippable coal, as well as along a line parallel to dip near Torreon, yielded 47 coal-core samples from 19 Menefee Formation, 4 Crevasse Canyon Formation and 5 Moreno Hill Formation locations in the Chacra Mesa field, Moreno field, and Gallup field of the San Juan Basin in northwestern New Mexico and the Salt Lake field in west-central New Mexico. Some coal beds encountered were too thin to be collected. Chemical analyses and representative petrographic descriptions characterize the sampled coals and indicate their commercial qualities.

0120 Mining

Refer also to citation(s) 27511, 28735, 28736, 28738, 28740, 28742, 29895

27469 (KIB-RUB-TWM–85-6, pp. 87-118) **Sprayed concrete in roadways and shafts of the Bergbau AG Lippe.** Thierse, D. (Bergbau AG Lippe, Gelsenkirchen (Germany, F.R.)). Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau. Sep 1985. (In German). (CONF-8502162–: 3. colloquium on sprayed concrete for tunneling and mining, Bochum (Germany, F.R.), 13 Feb 1985). In *Sprayed concrete for tunneling and mining.* Available from Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau.

Sprayed concrete as specified in DIN 18 551 is a mixture of fluxes and binders which is compacted by spraying onto a counterbearing and which according to DIN 1045 has a maximum grain size over 8 mm. Apart from this type of sprayed concrete, the article also discusses special constructional materials with grain sizes below 4 mm, e.g. sprayed mortar or colloid cement sprayed by a centrifugal spraying process. Applications, models for calculating bolted sprayed concrete supports, support construction, materials transport and packaging, composition and processing, head protection by means of consolidation in arched steels supports, convergence control, and economic aspects of sprayed concrete supports. (MOS).

27470 (NEI-FI–89) **Development of a rapid harvesting method for peat. Conclusions.** Suominen, A. (Turveteollisuusliitto ry., Helsinki (Finland)); Minkkinen, J.; Taimisto, T. Turveteollisuusliitto ry, Helsinki (Finland). 1985. 146p. (In Finnish). Order Number DE90770713. Available from NTIS (US Sales Only), PC A07/MF A01.

The aim of the research work was to find the most feasible alternatives of increasing the yield of peat per hectare and to test some methods found feasible in practice. Intensifying the drying of the production field and improving the harvesting stage of milled peat were chosen as the main objectives of experimental work, where the intensification of drainage and pneumatic harvesting were studied. Other alternatives of improving the yield per hectare are also discussed in the report. Advantages and drawbacks of narrow fields were studied on an industrial scale at two peat sites, one of them being a raised bog and the other a Carex dominated aapa mire. Differences in the groundwater level and in the moisture content of the top layer of the field were studied in fields of 10 m and 20 m in width. In good production fields, the ground water level was about 10 cm lower in the fields 10 m in width than in those 20 m in width. The moisture content of the top layer was reduced by 1.2-2.5 w-% for each 10 cm fall in the groundwater level. The work included the construction of a full-scale test machine for pneumatic harvesting by Haku and Peco methods. Production applications are presented for the test machine on fields 10 m in width and recommendations are given for developing the method further by using a pneumatic ridger mounted to a standard tractor. Despite higher costs of ridging or loading the unit costs of pneumatic harvesting were estimated to be 7-11% lower than those of mechanical scraper harvesting, thanks to the higher yield per hectare. A prerequisite of the development of pneumatic harvesting is that the ridger should be dimensioned to match tractors generally available for rent. The test machine can only be used with large special machines.

27471 (NEI-SE–50) **Peat exploitation upon Stormyran - effects on aquatic environment.** Olofsson, Hans. Uppsala Univ. (Sweden). Dept. of Limnology. 1989. 93p. (In Swedish). Order Number DE90770840. Available from NTIS (US Sales Only), PC A05/MF A01.

The peat-digging area is 60 hectares. The draining water together with runoff water from a forest and swamp zone of 310 hectares is supplied to the receiver Vinnfar-stream by the drainage canal from the digging area. Monitoring of precipitation, runoff and water chemical properties in surface and ground water has been accomplished for the years 1984-1986. The yearly precipitation was slightly below 1000 mm. The yearly runoff in the drainage canal was 450-540 mm of which 4-16 % represented the dewatering of the peat-digging area. The receiver investigation shows that the change in loading upon the Vinnfar-stream to a lesser extent influenced the mean concentrations of dissolved species in the stream. The loading of erosion materials resulted in strongly enhanced concentrations in the receiver periodically during the first two years. During these years the bottoms of the receiver were supplied with large quantities of mineral matter that changed the living bases of biota the nearest kilometers down-stream of the digging area. Estimates of the area losses from the digging area before and after ditching show that the losses of erosion materials, nutrient salts, and dissolved matters as a mean were 50, 10, and 5 times higher after ditching. The relative importance of erosion, ground water draw-off and mineralization of peat matter for these increases are discussed. (author) (8 ills., 17 tabs., 16 refs.).

27472 (NERDDP-EG–88-740) **In seam and cross measure methane predrainage by long-hole drilling.** Hungerford, F. (and others). National Energy Research, Development and Demonstration Council, Canberra (Australia). Dec 1987. 219p. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

The feasibility of long-hole drilling for in-seam and cross measure/in-seam gas drainage has been successfully researched at Appin Colliery. Accurately controlled in-seam boreholes have been

drilled to a maximum depth of 1004 m. The ability to drill cross measure and then guide the borehole within an underlying seam has been demonstrated, including branching from the trunk borehole. A new concept in gas drainage has been defined involving the use of long-hole cross measure/in-seam pre and post drainage to control longwall gas emissions. Computer simulation programs were developed and applied to define drainage designs and evaluate drainage effectiveness from a variety of scenarios. Particular emphasis was placed on modelling the effect of borehole pressure build up due to friction of the flowing gas with the borehole walls. Various borehole spacings were modelled to assess the effect on gas content reduction in time and space.

27473 (NERDDP-EG–88-742) **Underground mining research in the Collie Coalfield, Western Australia.** Humphreys, D.; Hebblewhite, B. National Energy Research, Development and Demonstration Council, Canberra (Australia). Dec 1987. 376p. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

The report describes the results of an ACIRL Research Project.This project has run for approximately eight years and came to an end recently with the successful extraction of two small trial total extraction mining panels using the Wongawilli method. Prior to this, underground coal mining in the Collie area of Western Australia was limited almost entirely to first workings, with some secondary pillar splitting operations. This was largely because of the very weak and highly saturated nature of the overlying strata which had, under certain circumstances, led to uncontrollable inrushes, slurry runs and mine flooding. The objective of this project was to investigate and implement methods of strata dewatering which would allow the application of total extraction methods of mining, thereby greatly increasing the recovery of the precious and limited reserves of coal in the Collie Basin.

27474 (NERDDP-EG–88-749) **Claystones of the Newcastle coal measures.** Seedsman, R.W.; Mallett, C.W. National Energy Research, Development and Demonstration Council, Canberra (Australia). Dec 1987. 84p. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

This project has used the Awaba Tuff as typical of the low strength claystones of the Newcastle Coal Measures. On the basis of extensive laboratory tests it is concluded the Awaba Tuff has very low strength and deformation properties and can undergo very large swelling strains or exert high swelling pressures if constrained. The Awaba Tuff may in many cases be weaker than the coal and be the weakest strata in the coal measures. Using the laboratory data in simple analyses it is shown that it is the low strength and deformation properties of the Tuff and not the swelling properties that must be considered critical for mine design. Roof instability has been analysed using arch and beam theories. On the basis of these analyses, it is suggested that bolting into roof claystones even when it is 'dry' is ineffective as a result of high required bolt loads and poor anchorage. As a result the claystone falls out of the roof and loads the top coal left in the roof to prevent claystone deterioration. A minimum thickness of 60 cm of top coal is required to ensure a stable roof. If water is present, or in the long term when pore pressures in the claystone equilibrate, no reasonable thickness of top coal will be sufficient to prevent roof instability. Floor instability has been more difficult to analyse. Although swelling will lead to a gradual lifting of the floor requiring dinting, it is believed that bearing capacity failure beneath pillars is the cause of rapid large-scale heave. The major conclusion of the study is that control of water is necessary but not sufficient to ensure roof and floor stability. A detailed examination of mine induced stresses and their relationship to claystone strength is required.

27475 (NERDDP-EG–88-758) **Design of a close aspect lighting system unit for continuous miner headings.** Bell, W.B. National Energy Research, Development and Demonstration Council, Canberra (Australia). Dec 1987. 189p. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

Previous work has shown that the coal face of a continuous miner location could be adequately lit by 4-15° machine headlights. Again, the addition of 6 - (screened) fluorescent luminaires to the rear of the 'miner' satisfactorily illuminated the floor and lower sidewalls. Visibility of the remainder of the walls and of the roof then depended on the backscatter of light from the coal face and the floor. However, this backscatter proved very effective and it was later shown that given the correct angle the surface reflectance was of little consequence to the emittance of that surface. To obtain surface emittance, the light source shoud be close to the surface of reflection and such positioning would also benefit by producing minimal light-path distance, thus reducing light loss due to dust and water. Experiments proving this 'Close Aspect' theory have shown its soundness and results are most encouraging. An ideal polar curve has been designed for maximum specular reflection in a typical continous miner location and exploratory tests with a Lambertian luminaire and an existing flameproof luminaire indicate the possibility of producing a low wattage luminaire capable of Close Aspect Technique characteristics to effect good locational luminance conditions when used with 'designed' headlights.

27476 (NERDDP-EG–88-769) **Design and engineering of lighting systems for the coal face: Volume 1, Main report.** Bell, W.B.; Daly, C.R. National Energy Research, Development and Demonstration Council, Canberra (Australia). Dec 1986. 382p. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

This report contains 3 chapters which cover the following topics: the present state of mine lighting throughout the world's coal producing countries; complete visual level requirements in low reflectance situations; mine lighting survey techniques; laboratory photometers and photometry; the lighting of continuous miner locations; the continuous miner model test laboratory; the computer simulation of continuous miner lighting applications.

27477 (NERDDP-EG–88-770) **Design and engineering of lighting systems for the coal face: Volume 2, Supplementary information.** Bell, W.B.; Daly, C.R. National Energy Research, Development and Demonstration Council, Canberra (Australia). Dec 1986. 390p. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

Contains appendices for each of the 3 chapters contained in volume 1 of the report.

27478 (PB–90-153644/XAB) **Development of certification procedures for blaster-in-charge. Volume 2. Test development and initial validation.** Edwards, D.S. American Insts. for Research, Washington, DC (USA). Jun 1980. 20p. Available from NTIS, PC A03/MF A01.

The report describes the development of the first two forms of the Blasters Certification Examination, and documents the results of the tryout of those tests.

27479 (PB–90-157132/XAB) **Evaluation of water-jet-assisted cutting capability on longwall shearers. Report of Investigations/1989.** Taylor, C.D.; Thimons, E.D.; Kovscek, P.D. Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center. 1989. 22p. (BUMINES-RI–9270). Available from NTIS, PC A03/MF A01.

The U.S. Bureau of Mines evaluated water-jet-assisted longwall shearers in full-scale laboratory tests and underground. Both test programs showed that use of high-pressure water did little to reduce the shearer motor energy required to maintain a given cutting rate. However, three other major benefits were achieved with the use of water-jet-assisted cutting. At 1,800 psi, respirable dust levels were reduced about 80% compared with the dust levels of the conventional water spray system operating at 340 psi. Operating at higher pressures required for water-jet assist also resulted in an increase in the average size of coal cut, which translates into a decrease in product fines. Finally, although no controlled measurements of bit wear as a function of water pressure were made, mine personnel reported that the shearer bits lasted longer when water-jet-assisted cutting was used.

27480 (PB–90-162496/XAB) **Subsidence monitoring using seismic activity. Final report.** Munson, R.D. Bureau of Mines, Denver, CO (USA). Denver Research Center. Nov 1987. 70p. Available from NTIS, PC A04/MF A01.

The occurrence of seismic events due to developing zones of subsurface subsidence was monitored using a near-surface geophone array. The active subsidence site is located in a residential area of northeast Colorado Springs, Colorado. Although a considerable number of events were observed during the ten-month monitoring interval, the source of only a few could be located. Despite the problems inherent of subsidence sites, results indicate that the geophysical method has the potential to detect activity that is indicative of initial subsurface subsidence, i.e., failure of the abandoned mine roof.

27481 (PB–90-170663/XAB) **Field evaluation of three longwall pillar systems in a Kentucky coal mine. Report of investigations/1989.** Barton, T.M.; Mark, C. Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center. 1989. 21p. (BUMINES-RI–9283). Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs.; Library of Congress catalog card No. 89-600199.

The U.S. Bureau of Mines is conducting research to assess the effectiveness of different chain pillar designs in maintaining gate entry stability. A particular concern is ground control for deep-cover longwalls located at depths in excess of 1,000 feet. The study described in the report was performed in two experimental sections in one longwall headgate section which contained three different pillar designs. Two of the designs used conventional abutment pillars, while the third was a total-yielding pillar system. Both of the test areas were located under 1,800 feet of cover. The purpose of the study was to evaluate the effectiveness of these three pillar designs for gate road stability. As the longwall mined passed the test areas, Bureau engineers monitored entry convergence, roof sag, and changes in roof quality. The study indicated that the all-yield system performed nearly as well as the better of the two abutment pillar systems, but all three designs would have failed to provide acceptable stability for second panel mining without considerable artificial support.

0130 Transport, Handling, and Storage

27482 (DOE/PC/88947–T6) **Development and utilization of new diagnostics for dense-phase pneumatic transport: Quarterly technical progress report, January 1–March 31, 1990.** Cornell Univ., Ithaca, NY (USA). [1990]. 6p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88947. Order Number DE90009648. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In this context, the main objective of this work is to develop probes for local measurements of solid velocity and holdup in dense gas-solid flows. In particular, capacitance probes are designed to measure local, time-dependent particle concentrations. In addition, a new optical fiber probe based on laser-induced-phosphorescence is developed to measure particle velocities. The principles for the capacitance and optical diagnostics were given in our first and second quarterly reports. In this reporting period, we have characterized the performance of the optical fiber anemometer probe, and we have modified a capacitance probe to permit simultaneous measurements of voidage and other local flow parameters near the wall. Another objective of this work is to develop a model of dense-phase conveying and to test this model in a setup that incorporates our diagnostics. In this period, we have begun to instrument the bench-scale facility that we will use to conduct experiments in the last phase of the project. 2 refs., 3 figs.

27483 (DOE/PETC/TR–90/5) **Mathematical modeling of fluid-solid mixtures.** Rajagopal, K.R. (Pittsburgh Univ., PA (USA). Dept. of Mechanical Engineering); Massoudi, M.; Ekmann, J.M. USDOE Pittsburgh Energy Technology Center, PA (USA). Mar 1990. 10p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90009152. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The flows of a mixture of solid particles and a fluid have relevance to several important technological applications. There are primarily two approaches that have been used for modeling such solid-fluid systems. In the first approach, the model is obtained by some kind of averaging of the equations of motion. In the second approach, the basic conservation laws are postulated and the ideas in continuum mechanics are used to arrive at appropriate constitutive relations. In this report we use this approach called mixture theory to derive the governing equations of motion for a steady one-dimensional fully developed pipe flow of a mixture of particles and a fluid. We present a brief historical account of the modeling of stress tensors for particles and the fluid. Finally, we discuss the importance of the boundary conditions. 24 refs.

27484 (NERDDP-EG–88-759) **Feeding of coal from mass-flow hopper outlets.** Arnold, P.C.; Mason, N.B. National Energy Research, Development and Demonstration Council, Canberra (Australia). Dec 1987. 79p. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

Coal handling continues to present industry with significant problems which, to overcome, result in the expenditure of considerable sums of money. While there are considerable efforts being made to reduce coal production costs, materials handling, which represents a considerable proportion of those costs, is still a generally neglected area. This project has demonstrated that reliable feeding systems for withdrawing coal from storage bins and bottom reclaim stockpiles are necessary if inefficiencies in the coal handling chain are to be minimised. The study has emphasised the need to recognise that the initial loads on feeders vary greatly from those experienced under flow conditions. These initial loads can and should be predicted independently of the flow loads and feeders must be designed with sufficient power to cope with these on a demand basis. Belt feeder loads and bin flow patterns are influenced significantly by such factors as hopper wall slope angle; hopper outlet size; hopper wall friction; belt feeder slope; belt feeder support; skirt and gate configurations. Throughout this project these influences have been studied for a belt feeder feeding from a wedge hopper. Techniques for predicting feeder loads are recommended and ways of reducing the high initial loads suggested. The influence of gates and skirts on the bin flow pattern is reported.

27485 (NERDDP-EG–88-760) **Long distance pneumatic conveying of fly ash and pulverised coal.** Arnold, P.C. (and others). National Energy Research, Development and Demonstration Council, Canberra (Australia). Dec 1987. 99p. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

Pneumatic conveying technology has been successfully applied to the transport of a wide variety of bulk solids, and in many cases offers industry an optimum solution to its materials handling requirements. Dense phase and long distance pneumatic transport have, in particular, gained increased attention - with the power generation industry in particular finding that some of its materials (fly ash and pulverised coal) are suited to this mode of transport. However, the knowledge available to industry for the successful use of this technology is limited which is restricting the potential applications and reducing the performance of existing installations. This project has sought to improve understanding in this area by: determining conveying characteristics for a number of fly ashes and pulverised coals over a range of pipeline configurations; examining a powder classification method that provides a guide to the suitability of a material to pneumatic conveying; demonstrating the effect different aeration methods can have on blow tank and overall system performance; further developing the scale-up procedures that allow test rig results to be used to predict the performance of plant installations; proposing an alternative correlation that improves the prediction of pipeline pressure drop due to solids; showing the effect of bends as a function of solids loading.

0140 Combustion

Refer also to citation(s) 27938, 27943, 27945, 27951, 28216, 28344, 28348, 28351, 29024

27486 (DOE/MC/21023–2758-Vol.1) **Second-generation pressurized fluidized bed combustion plant: Phase 1, Task 2 topical report—Grimethorpe tube bundle "E" wastage evaluation: Volume 1.** Kegel, W. Foster Wheeler Development Corp., Livingston, NJ (USA). Aug 1989. 114p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC21023. Order Number

DE90000407. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

Foster Wheeler Development Corporation (FWDC) took part in a pressurized fluidized bed combustion (PFBC) test program at the Grimethorpe PFBC facility in England. FWDC's participation included generating data to assess comparative wear rates and patterns on several different tubing alloys and surface protection techniques. The alloys and protection techniques are being used in, or are planned for, commercial atmospheric and pressurized fluidized bed boilers. Tubular specimens which were grouped into ten classes: carbon steel; finned carbon steel; finned 2-1/4%Cr-1%Mo; finned and studded carbon steel; finned and studded 2-1/4%Cr-1%Mo; finned and studded Type 347H stainless steel; chromized carbon steel; chromized 2-1/4%Cr-1%Mo; finned, studded and chromized carbon steel; and finned, studded and chromized 2-1/4%Cr-1%Mo. The materials are typical of those normally used in boiler service for carrying water, generating steam, and superheating steam. The test program and spanned approximately 1400 operating hours and was composed of three test sequences. Each test in the A2 series was run with a different fuel feedstock. The first utilized a UK coal (dry); the second evaluated a US coal/water mixture (slurry); the third test employed a UK coal slurry. Test runs with UK coal included a limestone sorbent while dolomite was used in the second test sequence. Exposed test specimens were removed for independent surface scale analysis before FWDC began metal wastage evaluations. The specimens were then inspected visually, analyzed dimensionally, and examined metallographically. 5 refs., 75 figs., 14 tabs.

27487 (DOE/MC/23256–2787-Vol.1) **Development and use of an advanced coal-fueled diesel engine cycle simulation with group effects, Volume 1: Final report.** Caton, J.A.; Annamalai, K. Texas A and M Univ., College Station, TX (USA). Dept. of Mechanical Engineering. Dec 1989. 171p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC23256. Order Number DE90000449. Available from NTIS, PC A09/MF A01 - OSTI.

The main objective of this study is to include the group effects of the vaporization and combustion processes in a CWS-fueled cycle simulation of a C.I. engine. A secondary objective of this study is to make additional improvements to the simulation, and to complete a parametric study of input parameters on performance, combustion conditions, and in-cylinder processes. The improvements to the simulation are the addition of a transient Nusselt number calculation for the heat transfer to the droplets, new flexibility in the entrainment model, the possibility of mass and diameter injection profiles other than the previously used "top-hat" profile, and a new devolatilization model. The next section presents a review of previous research efforts into both experimental coal-fueled engines, CWS-fueled engine cycle simulations, and analytical studies of group combustion behavior. Next, the model used in the current study is described. Finally, results from this study are presented and discussed followed by conclusions based on these results.

27488 (DOE/PC/60417–T1) **Development of retrofit external slagging combustor: Phase 1, Final technical report.** Avco-Everett Research Lab., Everett, MA (USA). Jul 1987. 160p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-84PC60417. Order Number DE90008441. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The overall objective of this program is utilization of coal in industrial and utility boilers now using a clan fuel (oil). Technical objectives are to obtain sufficiently high removal of coal mineral matter from the combustion products prior to entry into the boiler heat-exchanger components and to minimize the emission of particles. The management and major tasks were done by ARL for combustor testing in the modified MHD combustor and in the 25 x 10^6 Btu/hr Development Test Combustor. The existing MHD coal combustion test apparatus at the AL/Haverhill facility was reactivated and the modified combustor assembly with a new exhaust/after burner system was installed. About 40 tests were conducted with the modified combustor using standard power plant grind of Eastern Bituminous Coal to obtain data for the design of the Development Test Combustor. Tests were also performed using a finer grind coal (90% – 200 mesh). The design and fabrication of a 25 x 10^6 Btu/hr Development Test Combustor was based on the results obtained from preliminary combustion testing, flow modeling tests and analytical modeling of the combustor flow. More than 100 brief tests have been conducted so far in the Development Test Combustor in the thermal input range of 9–30 x 10^6 (Btu/Hr) using primarily Eastern Bituminous Coal, as well as Illinois No. 6 coal and North Dakota Zap Lignite. The slag/ash rejection achieved by the collector and in the exhaust duct was in the range of 50 to 70% depending on the coal type used and the level of the thermal throughput. 20 refs., 88 figs.

27489 (DOE/PC/88910–2) **Detoxification and generation of useful products from coal combustion wastes: Third quarterly technical report.** Arkansas Tech Univ., Russellville, AR (USA). Arkansas Mining and Mineral Resources Research Inst. [1990]. 13p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88910. Order Number DE90009390. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Coal flyash and bottom ash ground to –200 mesh for hardening tests. The mixes were allowed to harden for one mouth and were then removed from the sample cups and subjected to crushing tests. A subsample of the material was retained for cation exchange capacity testing. Results are described. 1 tab.

27490 (DOE/PC/88929–T4) **Scale-up of circulating fluidized bed coal combustors: Technical progress report, December 1, 1989–February 28, 1990.** Louge, M.Y. Cornell Univ., Ithaca, NY (USA). Sibley School of Mechanical and Aerospace Engineering. 1990. 7p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88929. Order Number DE90009558. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This project is aimed at quantifying the effects of scale-up upon the hydrodynamics of circulating fluidized bed coal combustors (CFB). To this end, we have constructed at Cornell a cold CFB facility that can operate with controlled fluidization gas mixtures. In addition, we have developed new diagnostics to measure local voidage in the bed. In order to test the new facility and its diagnostics, we have used an FCC powder to study in detail the voidage behavior near the wall of the CFB riser. In addition, we have developed a model for the hydrodynamics of the pneumatic transport of large particles, and a model for the transfer of heat in the same regime. In order to test these models in the CFB, we have begun developing new instruments to measure the collision frequency of particles with the wall of the CFB riser. Finally, in the previous quarter, we have started the first phase of our scale-up experiments by fluidizing glass beads using mixtures of helium and carbon dioxide. In the present reporting period, we have begun the second phase of our scale-up experiments and fluidized plastic pellets using different mixtures of helium and carbon dioxide. These experiments, combined with the data from last quarter's glass bead tests, provide preliminary indication of the effect of scale-up on the hydrodynamics of CFB coal combustors. 8 refs., 4 figs.

27491 (DOE/PC/89796–1) **Storage, transportation, and atomization of CWF for residential applications: Quarterly status report No. 1, September 27, 1989–December 31, 1989.** Breault, R. TECOGEN, Inc., Waltham, MA (USA). 1 Mar 1990. 42p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-89PC89796. (TR–4488-019-90). Order Number DE90009838. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Tecogen Inc. is developing a coal-water fuel (CWF)-fired advanced combustor for residential applications. The proposed program will examine the stability and rheology of the CWFs prepared from various beneficiated coal products made from Illinois No. 6, Wyodak, and Upper Elkhorn No. 3. Fuel coals characterization will include: particle size distribution, ultimate and proximate analyses of coal, ash composition, ash fusion temperature, and solids concentration. For rheological characteristics, data will be obtained at varying shear rates, temperature, and agitation or recirculation in the bulk storage tanks. The effect of freeze-thaw on the stability and rheology will be evaluated. Control of environmental conditions will be examined by means of formulation additives, including the addition of freezing point depressants and biocides. Bulk storage studies will involve testing CWF stability characteristics with and without agitation or recirculation. The design of the storage tank

will be reviewed, and the effectiveness of cone-bottom and dish-bottom tanks will be tested. This quarter, work was conducted on Task 1: project planning in the areas of preparing the program plan and the literature review, and in defining the system components. 16 refs., 11 figs., 2 tabs.

27492 (EUR–11748-EN) **Microfine coal combustion.** British Coal Corp., Stoke Orchard (UK). Coal Research Establishment. 1989. 98p. Available from Commission of the European Communities, Luxembourg.

This report deals with an investigation of the combustion characteristics of microfine coal (nominally 100% <44μ) with particular regard to the effect of coal size on flame length, fly ash particle size and ash fouling characteristics; flue gas emission levels (NO_x) for fine coal flames have also been quantified. Additionally, assessments have been made of currently-available milling methods for microfine coal preparation. The described studies have been performed on a variety of combustion systems ranging from 0.1-0.3 MW(t) capacity test rigs to a 4.3 MW(t) vertical shell boiler converted to microfine coal firing. Mathematical modelling procedures have also been developed. A reduction in coal size (to below that of normal-grade pulverised coal - typically, of mean size 45 μm) gave (i) a reduced support fuel requirement for ignition and flame stabilisation (ii) a reduced flame length (iii) a finer fly ash (iv) an increased furnace heat absorption. Ash collection rates (at a given gas velocity) were shown to be controlled principally by local gas temperature. For gas temperatures up to 1200°C, all deposits were friable and readily removed from the surfaces. An appreciable reduction in flame length (50%) can be achieved by using coal of, typically, 5μm mean size. Such coal was prepared in a fluid energy mill for which the specific energy consumption was high. For an unstaged burner the NO_x levels ranged from 1080-1260 mg Nm^{-3} (at 6% O_2). Mechanical milling of coal gave a product of 23μm mean size for which the reduction in flame length was 25%. The specific energy consumption was reduced by an order of magnitude. NO_x levels were shown to be within the range 400 to 600 mg Nm^{-3} (at 6% O_2), depending on the intensity of staging of the burner. 34 refs., 30 figs., 10 tabs.

27493 (EUR–12498-EN) **Production of industrial fuel gas for applications requiring high flame temperature and high emissivity.** British Coal Corp., Stoke Orchard (UK). Coal Research Establishment. 1989. 45p. Available from Commission of the European Communities, Luxembourg.

British Coal has developed a spouted fluidised bed gasification system for producing low calorific value fuel gas. This gas has a comparatively low flame temperature and emissivity. The objective of the work described in this report was to investigate means of improving these flame characteristics. Initial work modified an existing test furnace and developed test procedures. Two 280 kW nozzle mix burners were obtained and modified to give acceptable performance firing fuel gas. The maximum indicated flame temperature obtained firing cold fuel gas (3.6 MJ/m_n^3) and air using a Nuway burner was found to be about 1340°C. In general the most economic means of raising flame temperature is by preheating combustion air (and/or fuel gas). The emissivity of dust free fuel gas was measured at about 0.23, similar to natural gas but less than half that of liquid hydrocarbon fuels. Use of minimally cleaned fuel gas (containing about 6 g/m_n^3 of dust) was found to raise emissivity to about 0.24 - 0.28 at a calorific value of 3.6 MJ/m_n^3. Emissivity was raised further (to values up to 0.44) by injection of a liquid additive or use of an elevated calorific value fuel. Emissions of NO_x were quantified. Below a flame temperature of 1550°C thermally generated NO_x was negligable <10 ppmv, dry at 6% O_2. A significant proportion of fuel bound nitrogen was converted into NO_x on combustion so when ammonia and dust were present in substantial quantities this effect outweighed thermal NO_x, giving emissions in the range 130–380 ppmv. 17 refs., 13 figs., 15 tabs.

27494 (IEACR–21) **Management of AFBC [atmospheric fluidised bed combustion] residues.** Smith, I.M. IEA Coal Research, London (UK). c Feb 1990. 83p. Sponsored by International Energy Agency. Available from IEA Coal Research, Gemini House, 10-18 Putney Hill, London SW15 6AA, United Kingdom.

This review focuses on the potential for utilization of AFBC residues. The quantities of residues produced by AFBC are compared with those from other uses of coal. The sources of the wide variability in the chemical, physical and geotechnical characteristics of AFBC residues are examined with a view of optimizing them for disposal and utilization. Current legislation and associated leaching tests are reviewed critically with respect to their applicability to AFBC residues and the results of tests on the characterization of the leachates from AFBC residues are cited for different conditions. Disposal practices are described with details from some specific plants. Utilization options in agriculture, building and structural materials, pollution control and materials recovery are reviewed on the basis of available results from laboratory studies and demonstrations. It is concluded that management strategies for AFBC residues need to be optimized with site-specific conditions and requirements. Standard leaching tests are largely not capable of evaluating the long term leaching behavior of AFBC residues at disposal sites. Long term assessments are however required both for disposal and utilization. Whilst many appropriate uses for AFBC residues have been demonstrated, the wide variability of the residues is a major handicap to commercialization. 72 refs., 23 figs., 28 tabs.

27495 (NERDDP-EG–88-763) **Fly ash formation and sulphation during the combustion of brown coal.** Domazetis, G. (and others). National Energy Research, Development and Demonstration Council, Canberra (Australia). Dec 1987. 228p. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

This report presents an overview of investigations into the fly ash formation and sulphation process that occurs when brown coal is burnt. A code has been developed to simulate the chemistry of ash formation. The results of this project show that for the coals considered the chemistry of sodium species in a coal flame is central to the ash formation and fouling. Aluminium based additives have been tested on two Loy Yang coals. The tests show that the additives exert a pronounced influence on ash formation, probably via changes in the heterogeneous condensation of sodium compounds.

27496 (PB–90-155672/XAB) **Field evaluation of low-emission coal-burner technology on utility boilers.** Energy and Environmental Research Corp., Irvine, CA (USA). Dec 1989. 1191p. Available from NTIS, PC EE99/MF E99.

Set includes PB–90-155680 through PB–90-155722.

A separate abstract is included for each of the 5 volumes of this set.

27497 (PB–90-155680/XAB) **Field evaluation of low-emission coal-burner technology on utility boilers. Volume 1. Distributed mixing burner evaluation. Final report, September 1978–June 1986.** Abele, A.R.; Kindt, G.S.; Payne, R.; Waanders, P.W. Energy and Environmental Research Corp., Irvine, CA (USA). Dec 1989. 198p. Available from NTIS, PC A09/MF A02.

See also Volume 2, PB–90-155698; Also available in set of 5 reports PC E99/MF E99, PB–90-155672.

The report gives results of a study in which NOx emissions and general combustion performance characteristics of four burners were evaluated under experimental furnace conditions. Of primary interest was the performance of a low-NOx Distributed Mixing burner (DMB), which was tested in a nominal full-scale (120 million Btu/hr or 35MW) version and in a corresponding half-scale version. Performance was compared against a half-scale commercial low-NOx Dual Register burner (DRB) and a 120 million Btu/hr commercial Circular burner. The report documents the performance of each burner type over a wide range of firing conditions and for different bituminous and subbituminous coals. Additional test program goals were to provide information relating to the effects of burner design, burner scale, and thermal environment on NOx emission performance. Full- and half-scale DMB performance was compared under equivalent thermal conditions; the DMB was tested under two levels of furnace insulation; results from the DRB and Circular burner were compared to field data from two utility boilers operating with corresponding burner designs and coal types. A burner

zone heat liberation rate parameter was used to compare the relative performance of the different burners under the various firing conditions.

27498 (PB–90-155698/XAB) **Field evaluation of low-emission coal-burner technology on utility boilers. Volume 2. Second-generation low-NOx burners. Final report, September 1978–June 1986.** Abele, A.R.; Kindt, G.S.; Payne, R.; Waanders, P.W. Energy and Environmental Research Corp., Irvine, CA (USA). Dec 1989. 143p. Available from NTIS, PC A07/MF A01.

See also Volume 1, PB–90-155680 and Volume 3, PB–90-155706; Also available in set of 5 reports PC E99/MF E99, PB–90-155672.

The report describes tests to evaluate the performance characteristics of three Second Generation Low-NOx burner designs: the Dual Register burner (DRB), the Babcock-Hitachi NOx Reducing (HNR) burner, and the XCL burner. The three represent a progression in development based on the original Babcock and Wilcox DRB. Of particular interest was the identification of burner configurations which would be suitable for application in the EPA LIMB (Limestone Injection Multistage Burner) technology demonstration program at Ohio Edison's Edgewater Station, Unit 4. The retrofit requirements for this unit were used to establish burner performance criteria. The testing was conducted with nominal full-scale burner designs, having a capacity of 78 million Btu/hr (22.0 MW). Each burner was tested over a wide range of operating conditions and hardware configurations, and with different coals. However, the XCL burner was judged to have the best overall performance and to meet all the Edgewater boiler retrofit requirements. Additional brief tests were conducted to evaluate the impact of burner design on SO2 removal by injected sorbent materials.

27499 (PB–90-155706/XAB) **Field evaluation of low-emission coal-burner technology on utility boilers. Volume 3. Field evaluations. Final report, September 1978–June 1986.** Reese, J.A.; Abele, A.R.; Waanders, P.W. Energy and Environmental Research Corp., Irvine, CA (USA). Dec 1989. 253p. Available from NTIS, PC A12/MF A02.

See also Volume 2, PB–90-155698 and Volume 4, PB–90-155714. Portions of this document are not fully legible; Also available in set of 5 reports PC E99/MF E99, PB–90-155672.

The report gives results of field tests conducted to determine the emission characteristics of a Babcock and Wilcox Circular Burner and Dual Register Burner (DRB). The field tests were performed at two utility boilers, generally comparable in design and size except for the burner equipment. The Circular Burner was evaluated at Unit 2 of the Colorado Public Services Comanche Generating Station, and the DRB was evaluated at Unit 1 of the Wyodak Generating Station of the Pacific Power and Light Company and the Black Hills Power and Light Company. Of particular interest was the development of NOx emission correlations for the performance of Circular burners and DRBs under boiler conditions which could be used in interpreting individual burner tests in a subscale burner test facility. The field tests were conducted with both boilers operating at nominal full-load conditions. During each test, boiler performance and operating conditions were monitored using plant equipment, while gaseous emissions of NOx, O_2, CO, SO_2, and CO_2 were continuously monitored using a mobile test trailer.

27500 (PB–90-155714/XAB) **Field evaluation of low-emission coal-burner technology on utility boilers. Volume 4. Alternative concepts for SOx, NOx, and particulate emissions control from a fuel-rich precombustor. Final report, September 1978–June 1986.** LaFond, J.F.; Cole, J.A.; Li, W.C.; Moller, E.C.; Payne, R. Energy and Environmental Research Corp., Irvine, CA (USA). Dec 1989. 255p. Available from NTIS, PC A12/MF A02.

See also Volume 3, PB–90-155706 and Volume 5, PB–90-155722. Portions of this document are not fully legible; Also available in set of 5 reports PC E99/MF E99, PB–90-155672.

The report gives results of a study of the use of precombustors for the simultaneous control of SO_2, NOx, and ash emissions from coal combustion. In Phase 1, exploratory testing was conducted on a small pilot scale–293 kW (million Btu/hr)–pulverized-coal-fired precombustor to identify critical operating parameters. The results from this testing raised several questions regarding the viability of controlling SO_2 emissions by injecting calcium-based sorbent materials, under conditions simultaneously conducive to NOx control, and to the rejection of coal ash as a molten slag. In Phase 2, key elements of the sulfur capture process, under the fuel-rich precombustor conditions necessary to control NOx formation, were investigated. Detailed experimental studies were conducted at bench and laboratory scales to investigate the formation of stable sulfides in the entrained flow region of a precombustor, using calcium-based sorbents; study the evolution of sulfur from coal under entrained flow combustion conditions; and investigate the stability of sulfur species in molten slag layers. Study results indicated that the sulfidation reactions between CaO and H_2S or COS are fast and, under optimum conditions, can remove a high fraction of the gas-phase sulfur species in a fuel-rich precombustor.

27501 (PB–90-155722/XAB) **Field evaluation of low-emission coal-burner technology on utility boilers. Volume 5. Burner-evaluation-data appendices. Final report, September 1978–June 1986.** Abele, A.R.; Kindt, G.S.; Waanders, P.W. Energy and Environmental Research Corp., Irvine, CA (USA). Dec 1989. 342p. Available from NTIS, PC A15/MF A02.

See also Volume 4, PB–90-155714. Portions of this document are not fully legible; Also available in set of 5 reports PC E99/MF E99, PB–90-155672.

The report gives a detailed summary of data which were generated during the testing of experimental burners on EPA's Large Watertube Simulator (LWS) test facility. The test data are presented as a series of appendices. Appendix A describes the data quality assurance procedures which were used throughout the various tests. Appendices B and C summarize all the valid data obtained during the testing of the different burners. These data are presented as computer generated lists of all relevant furnace input data and flue gas measurements.

27502 (STEV-FBT–89-50) **Load control by slumping in fluidized bed boilers.** Andersson, S. (Chalmers Univ. of Tech., Goeteborg, (SE). Dept. of Energy Conversion). Statens Energiverk, Stockholm (Sweden). Mar 1989. 34p. Project STEV-276-201. Order Number DE90770794. Available from NTIS (US Sales Only), PC A03/MF A01.

The report consists of two papers: * The thermal behaviour of slumped zones in fluidized bed combustors, and * Load control by slumping and puffing in fluidized bed boilers. The first paper presents a model describing the gas flow, the gas and char concentrations, and the temperature field in the slumped zone. The modelled results are compared with measurements carried out at the 16-MW SFBB at Chalmers. The second paper deals with the measured temperature field in the slumped zone during a puffing sequence. Measurements were carried out for three sizes of the same coal in order to compare the influence of different coal reactivities. This work has given a good understanding of the phenomena of the slumped bed. The calculations and the measurements do not give a perfect agreement, but it is good enough to make the model useful. Also, it is shown that the puffing technique can be used, but extra care must be taken if limestone (or material with similar properties) is present.

27503 (STEV-FBT–90-2) **Heterogenous N_2O-reactions, FBC.** Miettinen, H. (Goeteborg Univ. and Chalmers Univ. of Tech., Goeteborg (SE). Dept. of Inorganic Chemistry); Abul Milh, M.; Nilsson, O.; Lindqvist, O. Statens Energiverk, Stockholm (Sweden). Oct 1989. 40p. (In Swedish). Project STEV-276-404. Order Number DE90770852. Available from NTIS (US Sales Only), PC A03/MF A01.

Laughing gas (N_2O) which represents one of the so called greenhouse gases accumulates in the atmosphere by natural and anthropogenic emissions. The anthropogenic discharges represent a considerable share. In later days it has been observed that combustion in fluidized beds cause more N_2O in the flue gases than other combustion technologies. The present study deals with breaking down and formation of N_2O under laboratory conditions in a fixed bed reactor. The gas mixtures investigated contain relatively high contents of the reactant gases diluted in argon as carrier gas. The following gas mixtures have reacted over various bed materials. N_2O, N_2O+H_2, N_2O+NH_3, N_2O+CO for study of the breaking down of N_2O. N_2+O_2, NO, NH_3, NH_3+NO, NO+CO,

NH_3+O_2 for study of N_2O formation. The bed material was quartz sand solely or mixed with 5% of each CaO, $CaSO_4$ and fly ash. The temperature range was 600-900 deg C. Gas analyses was done with mass spectrometer. The results show that the breaking down of N_2O is strongly temperature dependent. A considerably strong effect is obtained by addition of CaO or fly ash to the quartz sand bed. The breaking down temperature dropped ca 300 deg C, i.e. a nearly complete breaking down already at 700 deg C. The activity of the fly ash can be explained both by the pressure of CaO and unburnt material. Formation of N_2O from the mentioned gases has not been noted within temperature range investigated with the exception for reaction between NH_3 and O_2 at 600 deg C, when 10% N_2O was detected. It is noted that NO is broken down almost completely at 800 deg C with 5% fly ash in the bed material. (14 figs., 4 tabs., 20 refs.).

27504 (STU–88-949) **Combustion of droplets and particles.** Tao, Lixin (Royal Inst. of Tech., Stockholm (SE). Dept. of Heat and Furnace Techn.). Swedish National Board for Technical Development, Stockholm (Sweden). 26 Apr 1989. 64p. (In Swedish). Order Number DE90770766. Available from NTIS (US Sales Only), PC A04/MF A01.

A new vertical plug-flow type of turbulent flow reactor (TURE) was built in the project. Differing from the conventional drop tube furnaces, the reactor was designed to be able to operate in a wide range of flow conditions to give a maximum particle residence time 300 msec at a maximum Reynolds number based on the furnace diameter of 10000 with variable temperature of 1050-1600 deg K. The expected Kolmogroff size of turbulence in the reactor was in the order of 100 m which is within the interval estimated from realistic flames (75-250 m). A pulverized bituminous coal was employed to study the coal burn-off in the reactor. A mathematical model has been developed and fit to the experimental data from the reactor. This model consists of a two competing reaction scheme for the coal devolatilization and combined transport and chemical control of coal char oxidation. Information is presented on coal pyrolysis, char reactivity and external transport rate between solid and gas phases. Comparison between the numerical prediction and measured data show good agreement. Problems and further development based on the current work are also descussed. 25 figs., 10 tabs., 19 refs.

27505 (TKK-KO/ET–38) **Experimental research of pressurized fluidized bed technology and its application to power and heat cogeneration: Summary.** Jahkola, A. (Helsinki Univ. of Technology, Otaniemi (Finland)); Horvath, A.; Hulkkonen, S.; Boij, J.; Kurkela, E.; Moijtahedi, W.; Staahlberg, P.; Rautalin, A.; Raiko, M. Helsinki Univ. of Technology, Otaniemi (Finland). Inst. of Energy Engineering. 1989. 102p. (In Finnish). Project KTM-319/881/86. Order Number DE90770762. Available from NTIS (US Sales Only), PC A06/MF A01.

Pressurized fluidized bed combustion and gasification technology (PFBC/G) has many advantages over conventional methods of combustion. The efficiency of electric power generation is improved significantly and the power to heat ratio of power and heat cogeneration is essentially greater. The emissions of sulphur oxides can be reduced effectively and the emissions of nitrogen oxides are remarkable low. Pressurized fluidized bed technology is also well applicable for indigenous fuels. In the report the main results of the research project performed in Otaniemi 1987-88 are presented. The project has been realised partly theoretically based on literature research and computer runs but primarily by experimental measurements carried out using the PFBC/G test rig built in Otaniemi. The test rig was designed and built by Helsinki University of Technology (TKK), Technical Research Centre of Finland (VTT) and Imatran Voima Oy (IVO) and it was commissioned in summer 1987. The rig can be operated at pressured up to 10 bar, its thermal input is 130 kW as the combustor and 400 kW as the gasifier. The first, total 220 hours long serie of combustion trials was carried out in autumn 1987 and the first, total 170 hours long serie of gasification trials in the year 1988. The project was devided to four subprojects: operation and maintenance of the rig, material questions and safety aspects, pressurized combustion and hot gas clean-up, pressurized gasification and product gas cleaning, turbine technology and power plant processes. The project was financed besides by the involved parties also by the Ministry of Trade and Industry. From 1.1.1989 the project has been continued with approximately unchanged content within the combustion research program ┗IEKKI┛ however devided into two financially separated subprojects.

27506 (VTT-PUB–53) **Release of alkali metals in pressurised fluidised-bed combustion and gasification of peat.** Mojtahedi, W. (Valtion teknillinen tutkimuskeskus, Espoo (Finland). Polttoainejalostus- ja voiteluteknikan lab.); Backman, R. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Mar 1989. 50p. Order Number DE90770728. Available from NTIS (US Sales Only), PC A03/MF A01.

A combined-cycle power generation system incorporating pressurised fluidised-bed combustion (PFBC) or gasification (PFBG) is considered a promising approach for electricity generation using solid fuels such as peat. The these systems, the high-pressure hot flue gas is expanded in a gas turbine. Peat contains sodium and potassium which are released by combustion and gasification. These are corrosive elements that can cause severe damage to the turbine blades if not suppressed. Multicomponent, multiphase equilibrium calculations were carried out for atmospheric and pressurised fluidised-bed operating conditions to determine the distribution of sodium and potassium in the gas and condensed phases. Dependence of the alkali volatilisation on the operating temperature and pressure and on the sulphur content, total alkali content and chlorine content of the feedstock was studied. The results show that the alkali release in the vapour phase could be much higher than acceptable to a gas turbine, particularly under gasification conditions. Hence, the necessity to remove the volatilised alkali-metal compounds is more acute in gasification than in combustion. The results are also compared with the measured alkali content of pressurised fluidised-bed combustor and gasifier effstreams. Both sodium and potassium are present as chlorides and to a lesser extent as hydroxides in the gas phase in both modes of operation (i.e. combustion and gasification). However, whereas under combustion conditions both metals seem to condense as sulphates (Na_2SO_4 and K_2SO_4), in gasification, chlorides and carnates dominate in the condensed phase. The alkali metals volatilisation shows strong dependence on the operating pressure of the system as well as on the chlorine content of the feedstock. It decreases markedly with the former but increases sharply with the latter.

27507 **Coal-water slurry combustion in gas turbines.** Staub, F.W. (Corporate Research and Development, General Electric Co., Schenectady, NY (US)); Kimura, S.G.; Spiro, C.L.; Horner, M.W. *Journal of Engineering for Gas Turbines and Power (USA)*, 111(1): 1-7 (Jan 1989).

This paper presents preliminary results of a program to investigate the key technologies for burning coal-water slurries in gas turbines. Results are given for slurry atomization and combustion testing and analyses performed at conditions typical for gas turbine applications. Significant progress has been made toward the understanding of slurry combustion and ash deposition phenomena. Confidence has been gained to the extent where elimination of a supplementary pilot fuel can now be projected.

27508 **Looking beyond the demonstration plants.** Bajura, R.A. (U.S. Dept. of Energy, Morgantown Energy Technology Center, Morgantown, MV (US)); Halow, J.S. *Proceedings of the American Power Conference (USA)*, 50: 49-56 (1988). (CONF-880403–: American power conference, Chicago, IL (USA), 18-20 Apr 1988).

Atmospheric fluidized-bed combustion (AFBC), pressurized fluidized-bed combustion (PFBC), and integrated gasification combined-cycle (IGCC) systems, near-term, coal-based technology options for new, base-load capacity additions are being demonstrated in projects currently underway. Longer-term technology options can be envisioned that potentialy will have lower capital, operating, and maintenance costs particularly for small increments of new capacity, higher efficiencies, the ability to economically meet increasingly stringent environmental standards, shorter construction times, higher reliability, improved load-response characteristics, tolerance to a wide range of coal feed-stocks, and

infrastructure acceptability. Candidate longer-term technologies include gas turbine-based systems using air-blown, entrained flow gasifiers coupled with novel cleanup processes; PFBC systems utilizing a topping combustor; coal gasification/fuel cell systems; and coal-fueled gas turbines. This paper discusses the advantages and market niches of these longer-term technology options.

0150 Economic, Industrial, and Business Aspects

Refer also to citation(s) 27394, 27396, 27410, 27418, 29895

27509 (IEACR–20) **Current and prospective Australian coal supply.** Jamieson, E.D. IEA Coal Research, London (UK). c Feb 1990. 106p. Sponsored by International Energy Agency. Available from IEA Coal Research, Gemini House, 10-18 Putney Hill, London SW15 6AA, United Kingdom.

Part 1 of this report examines the international and national settings in which the Australian coal industry has developed, now operates and will have to live in future. Global factors beyond Australian coal but with major impact on the functioning of the largely export orientated industry, and the degree of industry exposure to those impacts are reviewed. This is followed by examination of the economic setting for Australian coal in terms of its contribution to national GDP, international trade and employment. The report goes on to assess the place of coal in the Australian energy scene and particularly in electricity generation. Part 2 assesses the current Australian coal situation by examining recent historical data and trends in relation to consumption, supply and trade; considers key physical and cost criteria in the current coal supply regime; defines important aspects of the evolution and current structure of the coal industry; reviews government policies, control mechanisms and institutions; and identifies required supply costs in the context of current prices and supply curves. Part 3 looks at the future of Australian coal supply in terms of cost availability and required price. Demand and supply projections are reconciled to produce an integrated picture of how projected demand may be met from existing supply sources and new projects. 63 refs., 31 figs., 21 tabs.

27510 (NEI-SE–53) **Peat-89. Production and use of peat 1988.** Statens Energiverk, Stockholm (Sweden). 14 Sep 1989. 48p. (In Swedish). Order Number DE90770795. Available from NTIS (US Sales Only), PC A03/MF A01.

Statistics on peat harvesting and use in Sweden is presented. During 1988 3.2 Mm^3 of energy peat was harvested, corresponding to 3.1 TWh - or 450 MWh/hectare of production area. In Sweden, peat is used almost exclusively in district heating plants; Industry and small heating plants stand for only about 3 percent of the peat use. (L.E.).

27511 (OY/PSTL-TIED–66) **The effects of utilization of domestic fuel on rural economy.** Kiukaanniemi, E. Oulu Univ. (Finland). Research Inst. of Northern Finland. Nov 1989. 21p. (In Finnish). Order Number DE90770714. Available from NTIS (US Sales Only), PC A03/MF A01.

The effects of utilization of domestic fuels on employment and income have been considered to be a significant factor supporting the use of domestic fuels. This summary report deals with the income and employment effects of peat and wood fuels on the size class level. The coarse development of prices of different harvestins chains of wood fuels is also presented. The peat delivery chain of the Toppila peat power plant is used as an example of employment and income effects of utilization of peat. It has been noticed that is is possible to estimated the employment and income effects of utilization of peat and wood fuels accurately for different size classes of possible objects of utilization. The need of accurate estimates arise not only in comparison of production and utilization chains of different fuels, but also in estimation of the effects of utilization of domestic fuels on employment.

27512 (PB–90-153560/XAB) **Economic analysis of alternative regulations for coal-processing waste. Draft report.** Mathtech, Inc., Princeton, NJ (USA). 3 Nov 1981. 29p. Available from NTIS, PC A03/MF A01.

Portions of this document are not fully legible.

The report assesses the economic impact of different levels of regulatory control over the disposal of coal processing waste. It provides a brief description of the research methodology and a summary of the regulatory costs, describes key cost items associated with the regulatory alternatives, compares the key provisions of each regulatory alternative, provides a regional cost analysis of these alternatives, and the appendix describes briefly the regional model mines as modified for purposes of this analysis.

27513 (PB–90-159500/XAB) **Economic evaluation of OSM (Office of Surface Mining) hydrology, geology, and air resources regulations. Final report.** Hittman Associates, Inc., Columbia, MD (USA). Jan 1982. 63p. Available from NTIS, PC A04/MF A01.

The report analyzes regulations identifying issues of potential economic impact by comparing existing and proposed regulations with pre-OSM state/federal regulations. Cost of compliance with current regulations including changes codified as of February 1, 1981 and proposed regulations under consideration by OSM. Compares incremental costs (cents/tons and cents/mil Btu) for coal produced from representative mines under existing and proposed regulations.

27514 (PB–90-160136/XAB) **Economic assessment of the impact on coal production due to enforcement of the Surface Mining Control and Reclamation Act of 1977. Benefits report. Volume 1. Final report.** Kyle, T.N.; McOmber, R.M.; Roberts, J.M. Orkand Corp., Silver Spring, MD (USA). 31 Oct 1980. 64p. (TR–81W-006). Available from NTIS, PC A04/MF A01.

The study assesses the major economic benefits and costs that are associated with the enforcement of the Surface Mining Control and Reclamation ACt (SMCRA). The report addresses the benefits of surface coal mining and land reclamation that follow from the Act. As originally conceived, the study was to evaluate, preferably in monetary terms, the specific benefits and socio-economic impacts of SMCRA. However, it was apparent, in the course of the initial analysis, that historical evaluation of specific benefits and socio-economic/environmental impacts is complicated by the short time that SMCRA has been in operation. It was also apparent that development of substantive, and defensible, quantified estimates of benefits and impacts is hindered by the absence of a great deal of needed numerical data, and by incomplete understanding of the reclamation processes that the Act is intended to enhance. Rather than attempt to evaluate specific benefits and socio-economic/environmental impacts, the study evaluated existing research studies on the impacts of surface mining, land reclamation, and SMCRA, and evaluated existing data sources relevant to surface mining, land reclamation, and SMCRA.

0160 Health and Safety

Refer also to citation(s) 28741

27515 (NERDDP-EG–88-702) **Genotoxicity of brown coal products.** MacPhee, D.G.; Silburn, K.A. National Energy Research, Development and Demonstration Council, Canberra (Australia). Jun 1987. 47p. Available from Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia.

The *Salmonella typhimurium* mammalian microsome mutagenicity assay was used to determine the mutagenic activity of brown coal-to-oil liquefaction products from laboratory scale reactors (23 samples) and the Morwell pilot plant facility (8 samples). All samples from the laboratory reactors except unreacted coal were clearly mutagenic. Increasing the temperature of the process appeared to result in an increase in the mutagenicity of the sample, while increasing the residence time had no significant effect. Of the pilot plant samples only the process solvent, coal liquid bottoms and coal slurry were mutagenic. All samples required activation and/or detoxification by mammalian liver microsomal enzymes before their mutagenic activity could be detected. Exposing samples to visible light enhanced mutagenicity. Alternative forward and reverse mutation assays (which might have been more sensitive or informative) were also investigated. Fractionation schemes to separate and hopefully identify the mutagenic components of liquefied oil samples have also been developed.

27516 (PB–90-154287/XAB) **Development of a prototype powered helmet respirator suitable for use in coal mines. Final**

report, July 1987-June 1988. Howie, R.M.; Best, C.F.; Dye, R.W.; Graveling, R.A.; Crawford, N.P. Institute of Occupational Medicine, Edinburgh (UK). May 1989. 45p. (TM–89/02). Available from NTIS, PC EE05/MF E05.

A powered helmet respirator (PHR), the Racal Airstream AH6, has been available to mineworkers at selected collieries for a number of years. However, experience has suggested that the AH6 is too bulky, too heavy and has too low an airflow for use in collieries. An IOM prototype PHR was developed, which was found in wearer trials to be significantly more acceptable than the AH6. However a number of design characteristics of the prototype still caused wearer dissatisfaction; in particular the airflow rate was perceived as being too low, the prototype, although lighter than the AH6, was still too heavy and the fans were too noisy. The prototype PHR was further developed to increase its acceptability under coal mine working conditions. The report describes the additional work carried out during the development.

27517 (PB–90-157082/XAB) **Performance-based approach to improve skills, safety, and training in the mining industry. Research report, September 1984-October 1989 (Final).** Klishis, M.J.; Althouse, R.C.; Grayson, R.L.; Lies, G.M. West Virginia Univ., Morgantown, WV (USA). Mining Extension Service. Oct 1989. 221p. Available from NTIS, PC A10/MF A02.

The Mining Extension Service of West Virginia University has developed an approach for identifying the specific training needs of mining operations (production, maintenance and support tasks) that can be used to upgrade on-the-job training, annual refresher training and task training. It can also be directed at systematically correcting performance discrepancies of an individual, a crew, or the mining operation, or to challenge workers and management toward attaining improved performances. Built on the systematic use of operational data, the Training in Operations Process (TOP) approach is designed to integrate features such as diligence in monitoring and evaluating performances into operational performance decisions. The approach may also be applied to other (non-training) interventions by mine management. Based on research on the state of training and worker performance in longwall mining, coal preparation plants, and underground haulage operations, this approach provides a practical five-step process for managers to implement and focus training so that it coincides with the organization's productivity and safety goals. The system permits management to plan, organize, and schedule task training, cross training, annual refresher training, and specialized skills training for miners' regular job assignments, and for their back-up, or fill-in-roles.

27518 (PB–90-159062/XAB) **Sampling and analytical procedures for the industrial-hygiene characterization of coal gasification and liquefaction pilot plants.** Enviro Control, Inc., Rockville, MD (USA). May 1979. 91p. Available from NTIS, PC A05/MF A01.

Industrial-hygiene sampling and analytical procedures adapted to coal conversion facilities are described. These procedures were designed for potentially hazardous substances believed to be present in the coal conversion facilities. Due to cost constraints, not all analytical procedures were carried out at each study site. Instead, the toxic substances have been ranked according to hazard and available sampling and analytical procedures, and a judicious selection was made of substances to be sampled and analyzed. High flow pumps were used for personal monitoring of polynuclear aromatics (PNAs) and for particulate and trace-metal sampling. Sampling equipment used for determining total particulates and trace metals was described. Noise exposure was also examined at this time, as were exposures to excessive heat and radiation. Specifics of the analytical processes used were given for the analysis of aromatic amines in the air, aromatic alcohols in the air, selected hydrocarbon vapors in air, total particulate matter in air, polynuclear aromatic hydrocarbons in air, airborne toxic gases, airborne trace metals, airborne thiophenes, and airborne mercaptans.

27519 (PB–90-161365/XAB) **Development of certification procedures for blaster-in-charge. Volume 1. Job analysis and determination of minimal experience requirements.** Hahn, C.P. American Insts. for Research, Washington, DC (USA). Jun 1980. 70p. Available from NTIS, PC A04/MF A01.

The project was designed to develop valid experience requirements, certification tests, and an outline of a training course to be used in a program which will ensure that all certified blasters-in-charge demonstrate that they have the required knowledge, skills, and abilities to perform blasting operations in accordance with Office of Surface Mining standards.

27520 (PB–90-161480/XAB) **Quantitative analysis of diesel particulate matter in respirable coal dust by Raman spectroscopy. Research report (Final), 1 January 1987-1 July 1988.** Cornilsen, B.C.; Carlson, D.H.; Loyselle, P.L.; Johnson, J.H. Michigan Technological Univ., Houghton, MI (USA). 15 Mar 1989. 63p. Available from NTIS, PC A04/MF A01.

The health effects of diesel exhaust, especially particulate, are a concern in the underground workplace. Diesel Particulate Matter (DPM) contains compounds which are mutagenic and some are known carcinogens. While coal dust has been an important health concern for a number of years, the concern about DPM is more recent. A means of measuring the concentration of DPM is prerequisite to the effective control and reduction of DPM. At the present time, there is no fully proven method to distinguish between diesel and coal particulate. In the research, the Laser Raman Quantitative Analysis (LRQA) method is applied to determine the amounts of respirable diesel and coal on a filter containing airborne particulate matter. Particulate samples were obtained during one week of underground air sampling work in August of 1987 in the Kerr McGee Galatia Mine. The particulate samples were collected using gravimetric personal samplers, a method similar to that used by U.S. mines to determine the airborne respirable coal dust concentrations. Results from the LRQA method are compared with those from the size-selective sampling method.

27521 (PB–90-163692/XAB) **Industrial-hygiene assessment of coal-liquefaction plants.** Cubit, D.A.; Tanita, R.K. Dynamac Corp., Rockville, MD (USA). Mar 1982. 232p. Available from NTIS, PC A11/MF A02.

An industrial hygiene assessment was conducted at five coal liquefaction facilities to determine employee exposures to suspected hazardous chemicals. Air sampling was performed to determine levels of polynuclear aromatics (PNAs), the simple aromatics, aromatic amines, and several toxic gases. The results of both area and personal air sampling showed that workers were exposed to numerous PNAs usually at low microgram per cubic meter concentrations. The light molecular weight 2 to 3 ring PNAs were found in the highest concentration with very small or no quantities of the 4 through 7 ring compounds detected. Highest exposures to PNAs were associated with maintenance activities being carried out in the process area during facility operation. The results of air sampling for aromatic amines, phenolic compounds and the simple aromatic compounds showed that these chemicals were present only at very low levels and that airborne exposures to these compounds may not be a major health hazard during normal operations. However, skin absorption would remain a concern. Nonquantitative wipe sampling for PNAs revealed the presence of up to 5 ring PNA compounds on most surfaces sampled, indicating that dermal exposure to higher ring PNAs may present a potential health hazard.

27522 (PB–90-170648/XAB) **Control of diesel particulate matter in underground coal mines. Report of Investigations/ 1989.** Watts, W.F.; Baumgard, K.J.; Cantrell, B.K.; Rubow, K.L. Bureau of Mines, Twin Cities, MN (USA). Twin Cities Research Center. 1989. 19p. (BUMINES-RI–9276). Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs.; Library of Congress catalog card No. 89-600165.

The U.S. Bureau of Mines has conducted research on methods to reduce and to measure diesel particulate matter (DPM) aerosols in underground coal mines. One objective of the report is to present findings from an investigation of the DPM reductions obtained by an engine-mounted integrated control system consisting of a dry system (DS) and a diesel particulate filter (DPF). Another objective is to present results from the use of a size-selective personal sampler to measure DPM concentrations in an underground coal mine. Bureau laboratory tests of the integrated dry system and diesel particulate filter (DS-DPF) have shown that DPM emissions can be reduced up to 97% with little change in gaseous

emission concentrations. The DS-DPF is undergoing certification tests conducted by the Mine Safety and Health Administration (MSHA). Subsequent to passing all safety requirements, it will be tested in an underground coal mine. A baseline survey of DPM concentrations and aerosol size distributions in a cooperating mine was completed in August 1988. A prototype DPM personal sampler was tested during the survey. Based on results from the test, an improved unit has been developed. The unit is scheduled for extensive field testing by MSHA in 1989.

27523 (PB–90-171265/XAB) **Proposed national strategies for the prevention of leading work-related diseases and injuries: Occupational lung diseases.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1986. 21p. (DHHS/PUB/NIOSH–89-128). Available from NTIS, PC A03/MF A01.

The document summarizes what actions need to be taken to prevent occupational lung diseases. It was developed in 1985 at a conference sponsored by the National Institute for Occupational Safety and Health and The Association of Schools of Public Health, which brought together over 50 expert panelists and 450 other occupational safety and health professionals.

0170 Legislation and Regulations

Refer also to citation(s) 27461

27524 (PB–90-167784/XAB) **Mineral planning in Great Britain and its relevance to the American mining industry (1981). Final report.** Saperstein, L.W. Pennsylvania State Univ., University Park, PA (USA). Dept. of Mining Engineering. 1 Nov 1981. 232p. Available from NTIS, PC A11/MF A02.

See also PB–90-150582.

The contents are: an analysis of US surface mining law and its attitude toward land-use planning; operation of the British mineral planning system; changes to American permitting practices suggested by observations of the British; a general impression of industrial planning in Great Britain; the British approach to topsoil restoration.

02 PETROLEUM

Refer also to citation(s) 28628

0202 Reserves, Geology, and Exploration

Refer also to citation(s) 27645

27525 (DOE/BC/14250–3) **Research on improved and enhanced oil recovery in Illinois through reservoir characterization: Technical progress report, December 29, 1989–March 28, 1990.** Oltz, D.F. Illinois Dept. of Energy and Natural Resources, Springfield, IL (USA). [1990]. 54p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-89BC14250. Order Number DE90009929. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The project provides information that can be used to maximize hydrocarbon production, minimize formation damage and thereby stimulate new and increased production in Illinois. Twelve project tasks are designed to examine in detail selected subsurface oil reservoirs in Illinois, thereby increasing knowledge of reservoir components and behavior, and aid development of methodologies having potential to increase the amount of recovered oil. Information to be provided includes assessment of hydrocarbon resources including an estimate of unrecovered mobile oil, characterization of hydrocarbon reservoirs, and the description of methods that will improve hydrocarbon extractive technology. Methods of analysis of reservoir complexities include subsurface mapping using log, core analyses, clay identification, petrographic thin sections, and predictive computer modeling. Data collected from 8 oil fields is discussed. 2 figs.

27526 (DOE/BC/14425–T3) **Establishment of an oil and gas database for increased recovery and characterization of oil and gas carbonate reservoir heterogeneity: [Progress report], January 1, 1990–March 31, 1990.** Mancini, E.A. Geological Survey, Tuscaloosa, AL (USA). [1990]. 7p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-89BC14425. Order Number DE90009919. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The objective of this project is to augment the National Reservoir Database (TORIS database) and to increase our understanding of geologic heterogeneities that affect the recoveries of oil and gas from carbonate reservoirs in the State of Alabama and to identify those resources that are producible at moderate cost. This objective will be achieved through detailed geological, geostatistical, and engineering characterization of typical Jurassic Smackover Formation hydrocarbon reservoirs in selected productive fields in the State of Alabama. The results of these studies will be used to develop and test mathematical models for prediction of the effects of reservoir heterogeneities in hydrocarbon production. Geological research this quarter has focused on descriptions of core material and petrographic thin sections from reservoirs producing from the Smackover Formation in southwestern Alabama, computer entry of pertinent data, and generation of maps and cross-sections.

27527 (DOE/BC/14483–4) **Natural resources information system for the state of Oklahoma: Quarterly report, January–March 1990.** Mankin, C.J. Oklahoma Geological Survey, Norman, OK (USA). May 1990. 14p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-89BC14483. Order Number DE90009483. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this research program is to continue developing, editing, maintaining, utilizing and making publicly available the Natural Resources Information System (NRIS) for the State of Oklahoma. The Oklahoma Geological survey, working with Geological Information Systems at the University of Oklahoma, has undertaken to construct this information system in response to the need for a computerized, centrally located library containing accurate, detailed information on the state's natural resources. Particular emphasis during this phase of development is being placed on computerizing information related to the energy needs of the nation, specifically oil and gas. Progress is described. 3 figs., 2 tabs.

27528 (Juel–2313) **Integrated study of an oil field in the Southern Po Basin, Northern Italy.** Wygrala, B.P. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Chemie 5 - Erdoel und Organische Geochemie; Koeln Univ. (Germany, F.R.). Oct 1989. 325p. Order Number DE90780271. Available from NTIS (US Sales Only), PC A14/MF A01.

This thesis contains an integrated study of the development and present state of an oil field in the Southern Po Valley operated by AGIP S.p.A. 'Integrated' indicates that an attempt has been made to investigate all relevant geological and geophysical aspects and to integrate this 'classic' information into a more detailed, quantified report using computer-aided basin simulation methods developed by Integrated Exploration Systems (IES) of Juelich. Several areas of special interest and importance will be discussed in more detail: the theoretical geological background of the numerical simulation of sedimentary basin development, the mechanical and thermal properties of lithotypes and the simulation of their effects, the development and effects of overpressure on hydrocarbon generation and migration and on the tectonic evolution of the structure, the effects of overthrusting on thermal histories. (orig./HP).

27529 (LBL–28442) **Effects of single fractures on seismic wave propagation.** Myer, L.R. (Lawrence Berkeley Lab., CA (USA)); Pyrak-Nolte, L.J.; Cook, N.G.W. Lawrence Berkeley Lab., CA (USA). Jan 1990. 8p. Sponsored by U.S. DOE Energy Research; U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900640–4: International conference on rock joints, Loen (Norway), 4-6 Jun 1990). Order Number DE90009191. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Detection and characterization of fractures, joints and faults remains an important problem in mining and geotechnical engineering, as well as in petroleum reservoir engineering. A theoretical model has been developed which predicts the amplitude and group time delay of the transmitted, reflected, and converted waves resulting from a plane wave incident upon a single fracture.

It is assumed that seismic stresses are continuous across the interface. Seismic particle displacements, however, are assumed to be discontinuous. For completely dry conditions, the magnitude of the displacement discontinuity is given by the ratio of the seismic stress to the stiffness, κ, of the fracture. If a fluid is present in the fracture, we postulate that, in addition to the displacement discontinuity, a velocity discontinuity exists which is equal to the ratio of the seismic stress to specific viscosity, η. The wave equation has been solved for two sets of boundary conditions, with each set incorporating both specific stiffness and specific viscosity. These boundary conditions have been designated as Kelvin and Maxwell models. 12 refs., 5 figs.

27530 (LBL–28443) **The effects of tortuosity on flow through a natural fracture.** Cook, A.M. (Lawrence Berkeley Lab., CA (USA)); Myer, L.R.; Cook, N.G.W.; Doyle, F.M. Lawrence Berkeley Lab., CA (USA). Jan 1990. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900646–11: 31. US symposium on rock mechanics, Golden, CO (USA), 18-20 Jun 1990). Order Number DE90009193. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Fractures can play a dominant role in the movement of fluid through rock media. As a result, much work has been done, both theoretically and experimentally, on laminar fluid flow through open fractures consisting of parallel plates of varying degrees of surface roughness. In many cases the behavior of the fluid can be described using the expression developed by Lomize (1951) and used by others such as Witherspoon et al. (1980). This equation has become generally known as the "cubic law equation" because flow rate is proportional to the cube of the aperture. Although the relation of fracture aperture to flow is obvious, tortuosity of the flow paths in a fracture may also have a significant effect on flow. In this paper the results of a series of flow tests performed on a naturally fractured siltstone sample taken at depth from an oil reservoir are presented. The results of flow measurements over a wide range of apertures showed that tortuosity was a primary factor in explaining the difference between the measured flow rates and those predicted by the cubic law equation. 11 refs., 5 figs.

27531 (SAND–89-2314C) **A local similarity model for turbulent natural convection along a vertical surface.** Webb, S.W. Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900619–3: 5. AIPA/ASME thermophysics and heat transfer conference, Seattle, WA (USA), 18-20 Jun 1990). Order Number DE90008344. Available from NTIS, PC A02/MF A01 - OSTI.

A local similarity turbulence model has been developed for natural convection along a vertical surface. The model is based on the eddy viscosity formulation of Cebeci and Khattab (1975) which was modified to operate in a local similarity mode. Comparison of the model to available data for air, water, and ethyl alcohol shows that the model gives reasonable velocity profile results. Use of the model in a finite difference mode integrated along the plate gives results essentially equivalent to the original approach. 22 refs., 7 figs., 1 tab.

27532 **Multigrid methods for three-dimensional petroleum reservoir simulation.** Dendy, J.E. (Los Alamos National Lab. (US)); McCormick, S.F.; Ruge, J.W.; Russell, T.F.; Schaffer, S. pp. 524 of Proceedings of the tenth SPE symposium on reservoir simulation. Society of Petroleum Engineers, Richardson, TX (USA) (1989). (CONF-890234–: 10. Society of Petroleum Engineers symposium on reservoir simulation, Houston, TX (USA), 6-8 Feb 1989). SPE 18409.

The purpose of this paper is to report on a preliminary study of a new multigrid scheme for solving three-dimensional problems of the type that arise from pressure equations in reservoir simulation. The basic idea of this new approach is to use both semicoarsening and plane relaxation in order to accommodate all types of anisotropies and heterogeneities. The scheme also simplifies and reduces the cost of the setup involved in automatic coarsening of the fine-grid equations. This paper presents the results of the new approach applied to several known test problems. A comparison of performance and complexity is made with the best solvers now in widespread use in reservoir simulation.

27533 **Mathematical model of oil generation, degradation, and expulsion.** Braun, R.L. (Lawrence Livermore National Lab., CA (USA)); Burnham, A.K. *Energy and Fuels (USA)*, 4(2): 132-146 (Mar-Apr 1990). DOE Contract W-7405-ENG-48.

The authors present a mathematical model (PYROL) for simulating oil generation, degradation, and other chemical reactions occurring during pyrolysis of petroleum source rocks over a specified history of temperature and hydrostatic pressure. The model also simulates compaction of the source rock and expulsion of a liquid water phase, a hydrocarbon-rich liquid phase, and a vapor phase. The governing equations for PYROL consist of the time derivatives of 150 variables: 32 vapor species, 32 liquid species, 19 solid species, and 67 other variables (including pore pressure, pore volume, and diagnostics).

0203 Drilling and Production

27534 (DOE/BC/10841–15) **Modeling and optimizing surfactant structure to improve oil recovery by chemical flooding at the University of Texas: Final report, October 1987–September 1988.** Schechter, R.S. Texas Univ., Austin, TX (USA). Dept. of Engineering. Apr 1990. 111p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-85BC10841. Order Number DE90000230. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Objectives of this program are (1) to characterize mineral oxide surfaces and to relate these parameters to surfactant adsorption, (2) to study chromatographic effects resulting from use of surfactant blends, (3) to understand the properties of microemulsions as they relate to surfactant structure, and (4) to develop a thermodynamic theory of microemulsions which includes surfactant structure, cosolvents, and surfactant blends as well as the properties of the system oil and water. This quarter, we have completed collecting a comprehensive suite of adsorption data for two surfactants–decyl and dodecyl sodium sulfonate. Zeta potentials have been measured under conditions closely matching those which prevailed at points along the isotherm. Also, the free energy required to assemble a water-continuous microemulsion starting with molecularly-dispersed surfactant and excess solubilizate molecules is examined in some detail. In addition, the partitioning of alcohol between an aqueous and a micellar phase has been studied and the specific sites at which alcohols bind to micelles considered. Finally, to explain the unusual dielectric properties of microemulsions, a model which represents a microemulsion as a mosaic of water and oil-continuous regions has been adopted. 56 refs., 39 figs., 4 tabs.

27535 (DOE/BC/10844–15, pp. 1-15) **Summary of FY 1988 studies.** McCormick, C.L.; Hester, R.D. University of Southern Mississippi, Hattiesburg, MS (USA). Dept. of Polymer Science. Apr 1989. In *Polymers for mobility control in enhanced oil recovery. Third annual report for the period October 1987-September 1988.* Order Number DE89000738. Available from NTIS, PC A06/MF A01.

The overall goal of this research is the development of water-soluble copolymers for use in EOR which rely on intra- or intermolecular association for mobility control. Such polymers should have significant advantages over traditional flooding polymers. Specific research objectives are as follows: Synthesis of hydrophobically modified copolymers which rely on molecular association at low concentrations for mobility control; Synthesis and characterization of hydrophobically modified copolymers which can serve as both surfactant and viscosifier in EOR; Determination of polymer hydrodynamic volume utilizing viscometry, low angle laser light scattering (LALS), dynamic light scattering (DLS), and size exclusion chromatography (SEC) techniques; Development of predictive models based on interrelationships of molecular structure and solution behavior under operational conditions of temperature, shearing stress, concentration, and ionic strength; Technology transfer to the Private Sector for scale-up and field testing; and Education and training of young scientists in innovative energy recovery research.

27536 (DOE/BC/10844–15, pp. 16-43) **Ampholytic terpolymers of sodium 2-acryl amido- 2- methyl propane sulfonate with 2-acryl amido- 2- methyl propane-dimethyl ammonium chloride and acrylamide: Synthesis and aqueous solution behavior.** McCormick, C.L.; Johnson, C.B. University of Southern Mississippi, Hattiesburg, MS (USA). Dept. of Polymer Science. Apr

1989. In *Polymers for mobility control in enhanced oil recovery. Third annual report for the period October 1987-September 1988.* Order Number DE89000738. Available from NTIS, PC A06/MF A01.

Synthesis and viscometric studies of a series of moderate-to-low charge density terpolymers of acrylamide (AM) with sodium 2-acryl amido- 2- methyl propane sulfonate and 2-acryl amido- 2- methyl propane dimethyl ammonium chloride have been conducted. Terpolymers were synthesized with varying molar feed ratios of the three monomers. Plots apparent viscosity versus polymer concentration revealed critical overlap concentrations (C) in the range of 0.10 to 0.14 g/dl. The reduced viscosity of the terpolymers exhibited only a slight decrease with increasing temperature. Reduced viscosity was also correlated with polymer composition, charge distribution, and molecular weight of the terpolymers. The low-to-moderate charge density terpolymers displayed viscosities 100% greater than the high charge density copolymers. The superior viscometric characteristics of the terpolymers were more evident as the polymer concentration approached C.

27537 (DOE/BC/10844–15, pp. 44-54) **Ampholytic terpolymers of sodium 3-acryl amido- 3- methyl butanoate with 2-acryl amido- 2- methyl propane-dimethyl ammonium chloride and acrylamide: Synthesis and absorbency behavior.** McCormick, C.L.; Johnson, C.B. University of Southern Mississippi, Hattiesburg, MS (USA). Dept. of Polymer Science. Apr 1989. In *Polymers for mobility control in enhanced oil recovery. Third annual report for the period October 1987-September 1988.* Order Number DE89000738. Available from NTIS, PC A06/MF A01.

Synthesis and absorbency studies of a series of moderate-to-low charge density terpolymers of acrylamide (AM) with sodium 3-acrylamido-3-methylbutanoate (NaAMB) and 2-acrylamido-2-methylpropane-dimethylammonium chloride (AMPDAC) are reported. Terpolymers were synthesized with varying molar feed ratios of the three monomers. Terpolymers containing greater than 1% charged groups were not water soluble, but formed hydrogels. Ampholytic terpolymers synthesized from monomer mixtures of 5% AMPDAC, 10% NaAMB, 85% AM gain 23,000% their original weight in deionized water and 3000% in 0.514 M NaCl.

27538 (DOE/BC/10844–15, pp. 55-68) **Associative n-decylacrylamide copolymers for EOR.** McCormick, C.L.; Middleton, J.D. University of Southern Mississippi, Hattiesburg, MS (USA). Dept. of Polymer Science. Apr 1989. In *Polymers for mobility control in enhanced oil recovery. Third annual report for the period October 1987-September 1988.* Order Number DE89000738. Available from NTIS, PC A06/MF A01.

Copolymers of acrylamide (AM) with 0.75 mole % n-decylacrylamide (C-10AM) have been synthesized by solution, micellar and microemulsion techniques. Only the micellar method gave a polymer that had a exponential increase in apparent viscosity above a critical concentration indicative of interpolymer hydrophobic association. The synthetic parameters involved in preparation of water-soluble, high viscosity polymers by the micellar polymerization technique were evaluated including molecular weight, hydrophobe content and surfactant/hydrophobic group molar ratios. In addition, terpolymers were synthesized of AM/C-10 AM and 3-23 mole % acrylic acid. These macromolecules were characterized by elemental analysis by low shear viscometry varying concentration, solution ionic strength, and pH.

27539 (DOE/BC/10844–15, pp. 69-86) **Algorithm development for the determination of molecular weight distributions from dynamic light scattering data.** Mettille, M.J.; Hester, R.D. University of Southern Mississippi, Hattiesburg, MS (USA). Dept. of Polymer Science. Apr 1989. In *Polymers for mobility control in enhanced oil recovery. Third annual report for the period October 1987-September 1988.* Order Number DE89000738. Available from NTIS, PC A06/MF A01.

A mathematical formulation of an algorithm for the determination of molecular weight distributions from dynamic light scattering (DLS) data was developed. A function fitting method with a generalized exponential function was utilized. A Levenburg-Marquardt constrained, nonlinear regression algorithm was employed in the development of the overall algorithm. Several restraints were applied to the solution search space which eliminated spurious solutions of the ill-conditioned regression function. These advances in the algorithm development decreased computation time and did not significantly diminish the correctness of molecular weight distribution estimation.

27540 (DOE/BC/10844–15, pp. 87-95) **Determination of the molecular weight distribution of a water-soluble polymer - dextran T500.** Mettille, M.J.; Hester, R.D. University of Southern Mississippi, Hattiesburg, MS (USA). Dept. of Polymer Science. Apr 1989. In *Polymers for mobility control in enhanced oil recovery. Third annual report for the period October 1987-September 1988.* Order Number DE89000738. Available from NTIS, PC A06/MF A01.

Quasielastic light scattering measurements were obtained for a dextran T500 sample and molecular weight distributions were determined by the GEX function fitting method. The number average molecular and weight average molecular weights were determined to be 220,000 and 480,000 daltons, respectively. These compared well with the molecular weights reported by the dextran manufacturer (M_N = 165,000 daltons, M_W = 480,000 daltons). The distribution function defined by the GEX function fit method was comparable with the distribution obtained by size exclusion chromatography.

27541 (DOE/BC/10844–15, pp. 96-108) **Use of multiple detectors in size exclusion chromatography of large water soluble polymers.** Dearman, D.; Hester, R.D. University of Southern Mississippi, Hattiesburg, MS (USA). Dept. of Polymer Science. Apr 1989. In *Polymers for mobility control in enhanced oil recovery. Third annual report for the period October 1987-September 1988.* Order Number DE89000738. Available from NTIS, PC A06/MF A01.

Information from a refractive index detector and differential pressure detector can be combined in size exclusion chromatographic analysis to determine molecular weight distributions of high molecular weight polymers provided that both synchronization and deconvolution of detector signals are performed. Experimental methods to detect and quantify signal convolution were developed. Mathematical techniques to correct signal convolution were applied with limited success.

27542 (DOE/BC/14286–1, pp. 16-34) **TORIS [Tertiary Oil Recovery Information System]: An analytical evaluation tool.** Ray, R.M.; Allison, E. Hardin-Simmons Univ., Abilene, TX (USA). Fairleigh Dickinson Research Center. Mar 1989. (CONF-8809301–: Improved oil recovery conference, Abilene, TX (USA), 11-13 Sep 1988). In *Proceedings of the improved oil recovery conference.* Order Number DE89000732. Available from NTIS, PC A15/MF A01.

The Tertiary Oil Recovery Information System (TORIS) is an evaluation system used in the Department of Energy (DOE) to provide information that research and policy development managers can use to plan and implement an efficient, effective oil research program. This paper briefly describes the major component groups contained in this analytical system, the methodologies employed in using the system, and discusses selected results which can be obtained from the system. This analytical capability is useful to other segments of the oil industry and identified portions of the analytical system are now available to the public through the DOE.

27543 (DOE/BC/14286–1, pp. 35-42) **Putting your reserve report to work.** Enquist, B.R. Jr. (Resource Evaluations, Inc., Dallas, TX (USA)). Hardin-Simmons Univ., Abilene, TX (USA). Fairleigh Dickinson Research Center. Mar 1989. (CONF-8809301–: Improved oil recovery conference, Abilene, TX (USA), 11-13 Sep 1988). In *Proceedings of the improved oil recovery conference.* Order Number DE89000732. Available from NTIS, PC A15/MF A01.

Reserve reports involve quite a bit of reservoir engineering study, but are usually prepared by consulting engineering firms for a variety of reasons: These firms offer an independent appraisal (often required by the financial or investor community), they have extensive experience and expertise in reservoir analyses, they have (or should have) the necessary tools to give competent answers quickly, and finally, they don't represent continuing overhead. This paper describes various types of cooperation between consulting firm and client and the benefits obtainable.

27544 (DOE/BC/14286–1, pp. 43-68) **West Kiehl alkaline-surfactant-polymer oil recovery system design and application.**

Pitts, M.J.; Clark, S.R.; Smith, S.M. Hardin-Simmons Univ., Abilene, TX (USA). Fairleigh Dickinson Research Center. Mar 1989. (CONF-8809301--: Improved oil recovery conference, Abilene, TX (USA), 11-13 Sep 1988). In *Proceedings of the improved oil recovery conference.* Order Number DE89000732. Available from NTIS, PC A15/MF A01.

The West Kiehl Unit, Crook County, Wyoming USA produces from a Minnelusa Lower B Sand reservoir. Original oil in place (OOIP) is estimated to be 238,480 m^3. Estimated ultimate primary oil production is 27,030 m^3 or 11% original oil in place (OOIP). The four secondary and tertiary oil recovery methods considered were conventional waterflood, mobility controlled polymer-augmented waterflood, alkaline-polymer augmented waterflood, and alkaline-surfactant-polymer augmented waterflood. Estimated ultimate oil recoveries are 95,390 m^3 (40% OOIP); 95,390 m^3 (40% OOIP); 95,390 m^3 (40% OOIP); and 135,934 m^3 (57% OOIP); respectively. The polymer-augmented waterflood is expected to deplete the field faster than a conventional waterflood with no increase in ultimate oil recovery. The alkaline-surfactant-polymer augmented waterflood is expected to extend life, to deplete the field faster than a conventional waterflood, and to increase ultimate oil recovery. The alkaline-surfactant-polymer technology has been implemented and early injection and production performances are encouraging. The two objectives of the flood are to recover additional oil beyond the water-oil relative permeability end point and to pilot this potentially significant technology. This paper discusses the goals for utilizing an alkaline-surfactant-polymer system at West Kiehl. Further, it details the development of the project which included laboratory studies, reservoir definition, primary production history, injection production history through the first year of injection, facilities design, and operation.

27545 (DOE/BC/14286–1, pp. 69-76) **Suspended solids removal from fresh water makeup for waterflood.** von Phul, S. Hardin-Simmons Univ., Abilene, TX (USA). Fairleigh Dickinson Research Center. Mar 1989. (CONF-8809301--: Improved oil recovery conference, Abilene, TX (USA), 11-13 Sep 1988). In *Proceedings of the improved oil recovery conference.* Order Number DE89000732. Available from NTIS, PC A15/MF A01.

Water injected into subsurface formations during waterflood operations can cause serious damage if not free of large suspended solids. This paper presents data demonstrating that heavily contaminated source water can be rendered useful for waterflood injection. Shown are the test system design, resulting data, and equipment that was installed in the field.

27546 (DOE/BC/14286–1, pp. 77-94) **The advantages of solids-free completion fluids.** Sharp, K.W. Hardin-Simmons Univ., Abilene, TX (USA). Fairleigh Dickinson Research Center. Mar 1989. (CONF-8809301--: Improved oil recovery conference, Abilene, TX (USA), 11-13 Sep 1988). In *Proceedings of the improved oil recovery conference.* Order Number DE89000732. Available from NTIS, PC A15/MF A01.

Oil and gas production is certainly a complex operation with a vast array of parameters which affect the outcome. Nature provides a set of initial conditions: depth, pressure, temperature, porosity, permeability, etc., of which the would-be producer must take note in order to be successful. However, perhaps the overriding parameter in oil and gas production is the permeability of the rock in which the hydrocarbons reside. The general underlying thesis of this brief paper is: The initial completion of an oil or gas well is critical to the ultimate performance of the well in terms of productivity as well as cost. The specific purpose of the paper is to discuss solids-free brines as completion or workover fluids. As mentioned above, the critical parameter in well productivity is permeability. The proper selection and use of completion fluids can protect the permeability of a production zone against damage.

27547 (DOE/BC/14286–1, pp. 95-116) **Proven novel gel treatments for production well water control.** Avery, M.R. (Pfizer Oil Field Products Group, Groton, CT (USA)); Burkholder, L.A.; Gruenenfelder, M.A. Hardin-Simmons Univ., Abilene, TX (USA). Fairleigh Dickinson Research Center. Mar 1989. (CONF-8809301--: Improved oil recovery conference, Abilene, TX (USA), 11-13 Sep 1988). In *Proceedings of the improved oil recovery conference.* Order Number DE89000732. Available from NTIS, PC A15/MF A01.

Current oil market economics dictate prudent, efficient, and cost effective production operations. Any unnecessary expenses must be avoided. One operational characteristic that is a problem to many producers is excessive water production. Numerous control techniques have been tried in the past, but few have been both technically and economically successful. Two novel chemical gel systems have been developed and field proven which address two major causes of past failures - reduction of oil permeability and treatment longevity. One system is applicable to formation temperatures up to 150 F and the other covers a range of 170-240 F. Both systems are patented approaches to the problem. This paper discusses the concepts behind the application of these systems, laboratory results, field case histories, and economics.

27548 (DOE/BC/14286–1, pp. 117-118) **Stimulation production is improved through improvements in gelled acid technology.** Johnson, D.E.; Burns, L.D.; Fox, K.B. Hardin-Simmons Univ., Abilene, TX (USA). Fairleigh Dickinson Research Center. Mar 1989. (CONF-8809301--: Improved oil recovery conference, Abilene, TX (USA), 11-13 Sep 1988). In *Proceedings of the improved oil recovery conference.* Order Number DE89000732. Available from NTIS, PC A15/MF A01.

Stimulation results from acid treatments of carbonate reservoirs are internally limited by the extent of live acid penetration, which is determined by the rate of acid spending and fluid loss. In recent years, the effort to control acid leakoff and reduce the rate of spending has caused the industry to focus on developing gelled acid systems. Numerous gelling agents have been used, including natural gums, biopolymers, synthetic polymers, and surfactants. Many of these materials have been used with only limited success, due to their inherent instability in live acid or spent acid brines, or incompatibility with common additives and contaminants. In 1983, a polymer was introduced which provides the desired characteristics of stable viscosity, acid retardation and compatibility with most of the common acid additives. It has since been successfully applied in more than 350 low rate and fracture acidizing treatments. This paper provides a description of Drilling Specialties Gelled Acid (DSGA) polymer and details of several case histories.

27549 (DOE/BC/14286–1, pp. 119-155) **Introducing EOR technology to independent operators.** Schoeling, L.G.; Green, D.W.; Willhite, G.P. Hardin-Simmons Univ., Abilene, TX (USA). Fairleigh Dickinson Research Center. Mar 1989. (CONF-8809301--: Improved oil recovery conference, Abilene, TX (USA), 11-13 Sep 1988). In *Proceedings of the improved oil recovery conference.* Order Number DE89000732. Available from NTIS, PC A15/MF A01.

Independent oil operators are reluctant to apply EOR techniques due to constraints on technical knowledge, unavailability of reservoir data, limited equipment resources, and a lack of confidence that the technology can be applied successfully. This paper describes how a research group stimulated application of permeability modification techniques by independent oil operators through an effective liaison program. The Tertiary Oil Recovery Project (TORP) at the University of Kansas has investigated the use of gel polymer technology to improve sweep efficiency. One system under study is a gelling solution containing a high molecular weight polymer, such as polyacrylamide, thiourea, and chromium(VI) which is injected into a formation. The thiourea reduces the Cr(VI) to CR(III) which reacts with the polymer to form a gel. The gel seals off, or effectively reduces the permeability of the channel or high permeability zone, diverting water subsequently injected into previously unswept portions of the formation. TORP has extensively tested this system in the laboratory and has worked with independents to field tests and demonstrate its applicability. TORP has been involved with independent operators in twenty-one field treatments involving the gel polymer technology. All but four of the treatments were successful in reducing water flow in the channel and thus reducing producing water-oil ratio. In addition, 11 of the projects also showed increased oil production. Considering the polymer usage and incremental oil recovered in all of the treatments, both successes and failures, approximately three barrels of incremental oil were produced per pound of polymer injected. Three successful field demonstration projects with independent operators using gel polymer technology are described.

27550 (DOE/BC/14286–1, pp. 156-162) **So you're going to do a CO_2 flood (Implementation of commercial scale CO2 flood projects).** Smith, L.R. Hardin-Simmons Univ., Abilene, TX (USA). Fairleigh Dickinson Research Center. Mar 1989. (CONF-8809301–: Improved oil recovery conference, Abilene, TX (USA), 11-13 Sep 1988). In *Proceedings of the improved oil recovery conference.* Order Number DE89000732. Available from NTIS, PC A15/MF A01.

This paper presents only an outline of the original presentation. The paper outlines the following: major project decisions; carbon dioxide flood technology; facilities schematic; and the Slaughter, Texas carbon dioxide project. Conclusions and recommendations are: carbon dioxide affects everything; installation requirements vary; resolve key issues early; detailed planning is mandatory; assign key people early; and focus on cost control.

27551 (DOE/BC/14286–1, pp. 163-179) **Control of water production using cross-linked polymers.** Harris, S.H. Hardin-Simmons Univ., Abilene, TX (USA). Fairleigh Dickinson Research Center. Mar 1989. (CONF-8809301–: Improved oil recovery conference, Abilene, TX (USA), 11-13 Sep 1988). In *Proceedings of the improved oil recovery conference.* Order Number DE89000732. Available from NTIS, PC A15/MF A01.

Polymers have been used to decrease water production in the Spence Dome Field in Big Horn County, Wyoming. Koch Production Limited applied the treatments to control water coning in the Madison formation. Alcomer 90L, a polyacrylamide copolymer, was dissolved in water, mixed with cross-linking chemicals, and injected into three production wells. Prior to treatment all three wells had been temporarily abandoned due to high water cut (over 99.8%). After treatment all three wells showed decreased water production. Total water production dropped from almost 2000 BWPD with fluid standing over the pumps, to just over 500 BWPD with all three wells pumped-off. Oil production increased from 4 BOPD prior to abandonment to almost 20 BOPD immediately after the treatment and averaged 13 BOPD over the next six months. The polymer treatments decreased the water cuts and lifting costs making the wells once again economical.

27552 (DOE/BC/14286–1, pp. 180-199) **Bahamian refining Yellar Gold Hydrocarbon Leachant - hydrocarbon leaching for oil recovery from tar, paraffins, and heavy oil.** Finell, F. Hardin-Simmons Univ., Abilene, TX (USA). Fairleigh Dickinson Research Center. Mar 1989. (CONF-8809301–: Improved oil recovery conference, Abilene, TX (USA), 11-13 Sep 1988). In *Proceedings of the improved oil recovery conference.* Order Number DE89000732. Available from NTIS, PC A15/MF A01.

For thousands of idle stripper wells uneconomic at today's low oil prices, only two alternatives exist: government mandated plugging and abandonment, or some form of stimulation to return them to economic flow rates. For many, Bahamian Refining Yellar Gold Hydrocarbon Leachant could be their salvation. Yellar Gold is not a solvent which merely cleans tar and paraffins out of a well bore but does not change them from one state to another. Rather, it is true leachant which leaches many kinds of hydrocarbons including tar, paraffin and asphaltic, and converts them to oil. Finell discusses the discovery in 1987 of Yellar Gold and the attributes of the hydrocarbon leachant. He examines the economic implications of hydrocarbon leaching for enhanced oil recovery, and provides expert opinions and reasoning for projections of production close to ninety percent of the top half of the decline curve arc. He details Yellar Gold applications for primary oil recovery (sand fracturing, acid treatments, etc.), and secondary oil recovery (hot oil, steam, surfactant, water flood). Free, hands-on tests by participants of Yellar Gold Hydrocarbon Leachant on their own tar or paraffin samples demonstrate the chemical's effectiveness.

27553 (DOE/BC/14286–1, pp. 200-228) **Polymer augmented waterflooding, a case history: Vernon field, Woodson County, Kansas.** Russell, J.E. Hardin-Simmons Univ., Abilene, TX (USA). Fairleigh Dickinson Research Center. Mar 1989. (CONF-8809301–: Improved oil recovery conference, Abilene, TX (USA), 11-13 Sep 1988). In *Proceedings of the improved oil recovery conference.* Order Number DE89000732. Available from NTIS, PC A15/MF A01.

Polymer augmented waterflooding is a process by which a dilute polymer solution is injected into a reservoir to enhance the performance of waterflood oil recovery. Improved recovery and accelerated production are achieved by reducing the mobility of the injected water relative to the reservoir oil and favorably modifying the vertical permeability profile of the reservoir rock. Usually the efficiency of recovery from a conventional waterflood is inversely proportional to the increase in oil viscosity of the reservoir fluid. This paper deals with a case history that illustrates the improved performance and economic feasibility of polymer augmented waterflooding in the Vernon Field in Eastern Kansas.

27554 (DOE/BC/14286–1, pp. 229-250) **New variations of chemical EOR and their economic potential: The ASP process (Alkaline - Surfactant - Polymer).** Ball, J.; Surkalo, H. Hardin-Simmons Univ., Abilene, TX (USA). Fairleigh Dickinson Research Center. Mar 1989. (CONF-8809301–: Improved oil recovery conference, Abilene, TX (USA), 11-13 Sep 1988). In *Proceedings of the improved oil recovery conference.* Order Number DE89000732. Available from NTIS, PC A15/MF A01.

Current world oil prices have forced a reevaluation of many enhanced oil recovery processes. One very promising approach is the use of low-cost alkaline chemicals combined with surfactants and polymers. It has been determined from the testing of hundreds of oils that acid number and API gravity are simplistic screening criteria and are essentially meaningless in many cases. Oil recovery displacements in the laboratory have resulted in residual oil saturations as low as with the micellar-polymer technology for as little as 10% of the chemical costs. For the right application, this technology has the potential for producing incremental oil for less that $3 per barrel. Since this technology is just being developed in the laboratory, no field results are available. However, several operators are presently making plans for field implementation.

27555 (FRNC-TH–3540) **Study of mechanisms accompanying ionic surfactant adsorption on solids for low interaction systems. Application to chemical enhanced oil recovery in sandstone deposits.** Poirier, J.E. Institut National Polytechnique, 54 - Nancy (France). Jun 1984. 365p. (In French). Order Number DE90773297. Available from NTIS (US Sales Only), PC A16/MF A01.

In this paper is studied the interaction adsorbate - adsorbent responsible for ionic surfactant adsorption at the interface mineral-aqueous solutions in systems used in EOR. Parameters of adsorption isotherms are described and mechanisms for adsorption maxima are proposed. Quartz and kaolin are studied for morphologic and surface properties. Electrochemical properties of the interface mineral-aqueous solutions are examined. Adsorption isotherms of sodium N-alkylsulfonate and sodium N-alkylbenzenesulfonate are analyzed.

0204 Processing

Refer also to citation(s) 27395, 27396, 27397, 27398, 27404, 27436, 27437, 27840

27556 (CONF-891131–, pp. 193-217) **Fischer-Tropsch naphtha upgrading.** Gregor, J.H. (UOP, Des Plaines, IL (USA)); Fullerton, H.E. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

UOP is in the final phase of the Light Fischer-Tropsch Product Upgrading Program sponsored by the US Department of Energy. Being evaluated is the potential for new petroleum-refining technologies used within a Fischer-Tropsch (F-T) upgrading complex. The goal is to maximize the yield of transportation fuel. The upgraded product may also find applications as petrochemical products. Pilot-plant and economic studies were designed to evaluate two new commercial processes. Each process upgrades a different portion of the light products produced by an F-T reactor. The experimental program involves the Cyclar and low-pressure CCR Platforming processes. The Cyclar process is a one-step conversion of LPG into aromatics. The first commercial Cyclar unit is expected on-stream before the end of 1989. The low-pressure CCR Platforming process is an extension of existing commercial

technology that is used to upgrade naphtha. Because this second-generation process operates at half the pressure of a typical first-generation unit, it achieves higher liquid-product yield for a given product octane.

27557 (FRNC-TH–3568) **Adsorption of gas mixtures on fixed bed. Application to fuel-gas valorisation.** Bossy, A. Institut National Polytechnique, 54 - Nancy (France). 1987. 267p. (In French). Order Number DE90773296. Available from NTIS (US Sales Only), PC A12/MF A01.

Gas separation by adsorption is studied for recovery of LPG in fuel-gas from refineries. First theoretical calculations are presented taking into account modifications induced by variation of gas rate due to adsorption or desorption: Front formation for adsorbable gases in an isothermal equilibrium model. Second order effect when one gas only is adsorbed. Optimum pressure for the non adsorbed gas recovery in the pressure swing adsorbtion process. Then experimental results are presented for propane recovery in a mixture hydrogen-ethane-propane. Ethane fixation on a molecular sieve is difficult. On the other hand propane is adsorbed on activated carbon and desorbtion by heating gives a propane-rich gas (around 90%).

27558 (SIEMENS-KWU-U9–414/89/013) **Upgrading of Venezuelan heavy crude. Continuation of the Orinoco feasibility study within the Venezuelan-German Agreement (Annex IIIB). Final report.** Gonzales, M.; Lezuo, A.; Kastner, W.; Kuenstle, K.; Ostendorf, F.J.; Reiter, K.; Rodriguez, J.; Thelen, H.J. Siemens AG Unternehmensbereich KWU, Erlangen (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Jun 1989. 105p. Contract BMFT 03E-6400-B. Order Number DE90780163. Available from NTIS (US Sales Only), PC A06/MF A01.

Within the framework of the Venezuelan-German Agreement, Annex 3B, the following projects were performed under the responsibility of Siemens, KWU-Group. Project No. 5: Development of a mathematical model for the design and simulation of field-scale systems for the distribution of two-phase water-steam mixtures. The model has been verified in a test rig under field conditions. Project No. 6: Investigation of different steam generating systems for the production of supercritical injection steam from water of varying quality for deep oil reservoirs and investigation of the effect on oil yield and cost-effectiveness. Project No. 9: Investigation of possible improvement to achieve more efficient fuel utilization by increasing the efficiency and availability of different facilities in the Lake Maracaibo area and economic evaluation. (orig.) With 28 refs., 2 tabs., 16 figs.

0206 Health and Safety

Refer also to citation(s) 27566

27559 (AD-A–216866/4/XAB) **Potential threats to offshore platforms.** Jenkins, B.M. Rand Corp., Santa Monica, CA (USA). Jan 1988. 26p. (RAND/P–7406). Available from NTIS, PC A03/MF A01.

Increasingly spectacular acts of terrorism have led to growing concern that terrorists will move beyond the symbols of society and directly attack its technological and industrial vulnerabilities. Offshore platforms have been frequently mentioned among the potential targets terrorists might attack. This concern, however, has not resulted in extensive research like that devoted to possible threats to nuclear facilities, which have also been frequently mentioned as possible future targets of terrorists. For one thing, offshore drilling does not invoke the fear inherent in the word nuclear, a fear that translates directly into heavy security for the nuclear industry. Neither does the construction of offshore platforms provoke anything like the kind of protest generated by the construction of nuclear facilities.

0207 Economic, Industrial, and Business Aspects

27560 (OPEC–90009426) **OPEC [Organization of the Petroleum Exporting Countries] at a glance.** Organization of the Petroleum Exporting Countries (OPEC), Vienna (Austria). [1990]. 23p. Order Number DE90009426. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; Organization of the Petroleum Exporting Countries, Obere Donaustrasse 93, A-1020, Vienna, Austria.

OPEC — the Organization of the Petroleum Exporting Countries — was formed more than a quarter of a century ago, as a result of a joint action undertaken by several countries which are members of the United Nations. The treaty establishing OPEC was registered at the United Nations Secretariat on November 6, 1962, under No. 6363. Later, OPEC also established relations with the Economic and Social Council (ECOSOC) under United Nations Resolution 1053, adopted on July 30, 1965. From its formation in 1960 until 1965, OPEC had its Headquarters in Geneva, Switzerland. Since September of the latter year, the seat of the Organization has been in Vienna, Austria. OPEC has always sought to maintain a stable oil market, in the interest of both producers, OPEC and non-OPEC, and consumer countries, developing and developed, which, given the present circumstances, can be ensured only through co-operation among all producers and between producers and consumers. "OPEC at a Glance" is aimed at providing a brief account of the Organization's history, explaining its policies, actions, operations and structure. It is a glance at OPEC. 14 figs.

0208 Waste Management

27561 (DGMK–387-1) **Analyses of polychlorinated biphenyls, dibenzodioxines and dibenzofuranes in used metal-working oils, formulated with chlorinated paraffins.** Lache, W.; Albers, G.; Lehmann, H. Deutsche Wissenschaftliche Gesellschaft fuer Erdoel, Erdgas und Kohle e.V., Hamburg (Germany, F.R.); Deutsche BP Benzin und Petroleum AG, Wedel (Germany, F.R.). Inst. fuer Forschung und Entwicklung; Natec-Gesellschaft fuer Naturwissenschaftlich-Technische Dienste mbH, Hamburg (Germany, F.R.); Deutsche Shell AG, Hamburg (Germany, F.R.). PAE-Lab. Oct 1989. 15p. (In German). Available from Copy held by UB/TIB Hannover.

Used oils from different metal working plants have been analyzed. There was no indication of a formation of polychlorinated biphenyls. Neither tetra-, penta- and hexachlorinated dibenzodioxines nor polychlorinated dibenzofuranes have been found. (orig.) With 3 tabs.

0209 Environmental Aspects

Refer also to citation(s) 29039

27562 (AD-A–216795/5/XAB) **Installation-restoration Program, Phase 2. Confirmation/quantification, Stage 1. Kalispell Air Force Station, Montana. Final report, October 1986-March 1989.** Winar, R.M.; Bergstrom, M.F.; Doornbos, M.H. Battelle Columbus Div., Golden, CO (USA). Denver Operations. 1 May 1989. 259p. Available from NTIS, PC A12/MF A02.

Battelle conducted a literature search and field investigation into the environmental effects of a 1981 diesel fuel spill at Kalispell Air Force Station. Site selection was based on IRP Phase I recommendations, the Phase II presurvey, and discussions with OEHL and the Base POC. Shallow soil samples, ground water samples, and surface water samples were collected and analyzed. Chemical analysis of all samples included tests for aromatic organic chemicals and petroleum hydrocarbons. The contamination in Phase II, Stage 1 does not appear to constitute any serious risk to human health or the environment. The site is rated as Category I; no further is action needed.

27563 (DGMK–449-01) **Emission of methane by the gas and oil producing industry in the Federal Republic of Germany in 1988.** Lillie, W. (Gewerkschaften Brigitta und Elwerath Betriebsfuehrungsgesellschaft mbH, Hannover (Germany, F.R.)). Deutsche Wissenschaftliche Gesellschaft fuer Erdoel, Erdgas und Kohle e.V., Hamburg (Germany, F.R.). Aug 1989. 8p. (In German). Available from Copy held by UB/TIB Hannover.

In this study the volumes of unburned methane have been established, which were emitted by the gas and oil industry in the Federal Republic of Germany in 1988. Assessed were those volumes which were released in the course of production, treatment

and purification excluding transmission and underground storage. This detailed investigation, which was carried out as a joint venture of all operating companies, revealed that some 20.56 million m^3 (14,750 t) methane were emitted following the production of some 16.32 billion m^3 raw gas, i. e. 0.13%. Some 5.86 million m^3 (4,200 t) methane were released in connection with the oil production of 3.92 million t, i.e. 0.11%. In relation to the 1988 gas and oil production an aggregate amount of 26.42 million m^3 methane were emitted into the atmosphere. This volume corresponds to 0.16% of the total gas production (raw gas and associated gas) of 16.51 billion m^3. (orig.) With 1 tab.

27564 (DGMK–449-02) **Emission of methane from petroleum refining and petroleum products storage and distribution in the Federal Republic of Germany in 1988.** Altmann, B.R. Deutsche Wissenschaftliche Gesellschaft fuer Erdoel, Erdgas und Kohle e.V., Hamburg (Germany, F.R.). Oct 1989. 12p. (In German). Available from Copy held by UB/TIB Hannover.

On the basis of only few available data an assumption is made for methane-emission in the Federal Republic of Germany in 1988 from petroleum and petroleum products storage and distribution. Resulting methane-emission is in the order of magnitude of 1.000 t/a. Main contributor is refining. With about 90 Mio. t production specific methane-emission in Federal Republic of Germany refineries is about 0.001%. (orig.) With 13 refs.

27565 (ORNL/FTR–3571) **[Site visit to US Antarctic Program (USAP) facilities and the Research Vessel Polar Duke]: Foreign trip report, March 13–24, 1990.** Reed, R.M. Oak Ridge National Lab., TN (USA). 4 Apr 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009396. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Site visit to the US Antarctic Program (USAP) Facilities at Palmer Station and the Research Vessel Polar Duke: information collection for an environmental impact statement. (CBS)

27566 (PB–90-151143/XAB) **Assessment of environmental, health, and safety issues related to the use of alternative transportation fuels. Topical report, January-October 1989.** Klausmeier, R. Radian Corp., Austin, TX (USA). 10 Oct 1989. 226p. Available from NTIS, PC A11/MF A02.

See also PB–90-151168.

The study surveyed the current literature about environmental, health, or safety aspects related to the following fuels: gasoline, diesel, CNG, OXY fuels, M85, M100 and LPG. The emphasis of the report is on environmental issues including: attainment and maintenance of NAAQS for ozone, CO, and particulate; air toxics; acid rain; global warming; and groundwater/soil contamination.

27567 (PB–90-153214/XAB) **Superfund Record of Decision (EPA Region 1): O'Connor Company Site, ME. (First Remedial Action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 27 Sep 1989. 226p. (EPA/ROD/R–01-89/038). Available from NTIS, PC A11/MF A02.

Portions of this document are not fully legible.

The O'Connor site covers a 9-acre area near the city of Augusta, Maine. The F. O'Connor Company began operating a salvage and electrical transformer recycling business at the site in the early 1950s. Because of previous oil spills the State investigated the site in 1976 and found the surface water, sediment, and soil contaminated with PCBs. As a result of the study the F. O'Connor Company constructed two surface water impoundments (lagoons) to control further migration of oils from the site. In 1977 the State ordered the F. O'Connor Company to discontinue use of the lagoons. Subsequently the lagoon waters were pumped into several onsite storage tanks and the sediment was excavated, deposited in a low area onsite, and covered with a clay cover. The sediment created a barrier for surface water and formed an upland marsh onsite. In May 1987 EPA and the State jointly issued an amended Administrative Order to F. O'Connor Company required field investigations and extensions of the existing fence to areas where additional contamination was found. The primary contaminants of concern affecting the soil, sediment, ground water, and surface water are VOCs including benzene, other organics including PCBs and PAHs, and metals including lead.

27568 (PB–90-156217/XAB) **Outer Continental Shelf environmental assessment program. Final reports of principal investigators. Volume 64. Final report.** National Ocean Service, Rockville, MD (USA). Office of Oceanography and Marine Assessment. Nov 1989. 447p. Available from NTIS, PC A19/MF A03.

See also PB–90-115718.

Contents include: oil-ice-sediment interactions during freezeup and breakup; user's manual for the computer codes: OILSPMXS, SPMONLY, OILSPM3.

27569 (PB–90-162629/XAB) **Superfund Record of Decision (EPA Region 7): John's Sludge Pond, Wichita, KS. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 22 Sep 1989. 44p. (EPA/ROD/R–07-89/025). Available from NTIS, PC A03/MF A01.

The Johns' Sludge Pond site is in a relatively undeveloped area in the city of Wichita, Sedgwick County, Kansas. During the 1950s and 1960s the Super Refined Oil Company used the sludge pond for the disposal of waste oil and up to 15,000 cubic yards of oily sludge generated by the oil recycling and reclamation operation. Because sulfuric acid was used to refine waste oil for recycling, the wastes dumped into the pond were very acidic. Additionally, high lead concentrations and low PCB concentrations (less than 50 ppm) were also detected in the sludge. As surface water flowed into the pond, an extremely acidic layer of water formed on top of the sludge which often overflowed into nearby surface waters. The city subsequently built berms to prevent further surface runoff. In 1983 EPA ordered the city to undertake interim cleanup activities which consisted of excavating and solidifying the sludge using cement kiln dust with redeposition of the treated sludge into a compacted clay-lined cell followed by capping using a compacted clay cap. Surface and ground water monitoring following the interim action have not detected any contaminant levels that would require further action.

27570 (PB–90-162660/XAB) **Superfund Record of Decision (EPA Region 8): Woodbury Chemical, Commerce City, CO. (Second remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 53p. (EPA/ROD/R–08-89/026). Available from NTIS, PC A04/MF A01.

See also PB–85-249464. Portions of this document are not fully legible.

The Woodbury Chemical Site is in Commerce City, a northern suburb of Denver, Colorado, and neighbors a primarily industrial area which includes automobile salvage yards and a petroleum refinery. From the 1950s to 1971, the Woodbury Chemical Company operated a pesticide formulation facility which was destroyed by fire in 1965 but was subsequently rebuilt. Contaminated rubble and debris from the fire was disposed of on a 2.2-acre vacant lot east of the Woodbury facility. During a 1985 remedial investigation of the 2.2-acre lot, EPA identified high levels of pesticides and metals in surface and subsurface soils. As a result of the discovery of additional contamination, EPA determined it would be more cost effective to simultaneously implement the cleanup activities at the 2.2-acre lot, the Woodbury chemical facility, and adjacent properties. The selected remedial action addressed in the Record of Decision (ROD) incorporates and builds upon the 1985 ROD. The primary contaminants of concern affecting the soil are VOCs including PCE and TCE; other organics including pesticides; and metals including arsenic.

27571 (PB–90-162793/XAB) **Superfund Record of Decision (EPA Region 5): Wausau Water Supply, Wisconsin. (Second remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 95p. (EPA/ROD/R–05-89/109). Available from NTIS, PC A05/MF A01.

See also PB–89-229520.

The Wausau Water Supply site, also known as the Wausau Ground Water Contamination site, is in Wausau, Marathon County,

Wisconsin. Three primary source areas of ground water contamination have been identified; a municipal landfill, the Wausau Chemical Company, and the Wausau Energy Company. The landfill appears to be the predominant source of TCE contamination in the underlying aquifer. On the east side of the river the Wausau Chemical and Wausau Energy companies are suspected sources of soil and ground water contamination due to spills from past operations. Wausau Chemical, a bulk solvent distributer, was responsible for spilling 1,000 gallons of PCE-contaminated waste in 1983 alone. Wausau Energy, a petroleum bulk storage and disposal center, has reportedly contaminated soil and ground water with petroleum by-products. To provide sufficient water of acceptable quality EPA temporarily installed a granular activated carbon treatment system on one well in 1984 and VOC stripping towers at the municipal water treatment plant to treat water from two contaminated wells. The city has been blending treated water with uncontaminated water to reduce VOC levels.

27572 (PB–90-164393/XAB) **Outer Continental Shelf oil and gas program: Cumulative effects.** Horn, W.V.; Melancon, A.; Sun, J. Minerals Management Service, Herndon, VA (USA). Atlantic OCS Region. Sep 1988. 230p. (OCS/MMS–88/0005). Available from NTIS, PC A11/MF A02.

The Outer Continental Shelf Lands Act (OCSLA) (43 U.S.C. 1331-1356) requires the Secretary of the Department of the Interior to submit an annual report to Congress assessing the cumulative environmental effects of mineral leasing and operations carried out under the OCSLA. The first report which covers the period 1954-1987 for activities off the Atlantic Coast, the Gulf of Mexico, the Pacific Coast, and offshore Alaska. Although temporary and localized impacts have occurred, with the exception of some loss of wetlands in Louisiana, significant adverse cumulative impacts on the human, marine, and coastal environments have not been identified.

27573 **Petroleum contaminated soils. Volume 2.** Calabrese, E.J. (Massachusetts Univ., Amherst, MA (USA). Dept. of Public Health); Kostecki, P.T. 515p. Lewis Publishers, Chelsea, MI (USA) (1989). (CONF-8809413–: 3. national conference on the environmental and public health effects of soils contaminated with petroleum products, Amherst, MA (USA), 19-21 Sep 1988).

This book presents the proceedings of the Third National Conference on Petroleum Contaminated Soils, provides an assessment of where the field is with respect to the problem and research as well as specific technical areas such as analysis, environmental fate, remedial techniques, public health assessment, and regulatory approaches. The goal of this book is to provide an historical sense of the problems, practical approaches and for their solutions within the context of regulatory approaches.

27574 **An overview and suggested methodology to determine the adequacy of cleanup of contaminated soils.** Rubel, F.N. (Environmental Protection Systems, Fairlawn, NJ (US)); Burgher, B.J.; McGriff, E.C. pp. 515 of Petroleum contaminated soils. Volume 2. Calabrese, E.J.; Kostecki, P.T. Lewis Publishers, Chelsea, MI (USA) (1989). (CONF-8809413–: 3. national conference on the environmental and public health effects of soils contaminated with petroleum products, Amherst, MA (USA), 19-21 Sep 1988).

The authors discuss solutions to address environmental contamination events exit. New advances in this field occur daily, both as a result of actual experience gained, as well as from applied research being widely conducted regarding cleanup techniques and criteria. The greatest difficulty encountered in connection with environmental contamination events involve socioeconomic issues. The term environmental gridlock is used to describe this difficulty. A key issue in this regard is the decision about the adequacy of cleanup. Such decisions are generally subject to public and private sector scrutiny. Cleanup standards for soils (i.e.), the polychlorinated biphenol [PCB] spill cleanup policy issued by the Environmental Protection Agency (EPA0, under its Toxic Substances Control Act program, and the U.S. Department of Energy guidelines for residual radioactivity at formerly utilized sites under its remedial action and remote surplus facilities management program) are discussed and assessed. Present cleanup standards for contaminated soil generally do not exist. There is a reliance on case-by-case determination, which may not always be consistent or systematic.

0230 Properties and Composition

Refer also to citation(s) 27654

27575 (CONF-900615–1) **Development of a computational fluid dynamics and chemistry model for the fouling of jet fuels.** Krazinski, J.L. (Argonne National Lab., IL (USA)); Vanka, S.P.; Pearce, J.A.; Roquemore, W.M. Argonne National Lab., IL (USA). 1990. 41p. Sponsored by U.S. Department of Defense; U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From 35. international gas turbine and aeroengine congress and exposition (TURBO Expo); Brussels (Belgium); 11-14 Jun 1990. Order Number DE90005664. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A new approach has been devised in which Computational Fluid Dynamic and Chemistry (CFDC) models are employed to predict the fluid mechanics, heat transfer, and deposition in fuel system components. The structure of this model is such that is has the potential of being used as a tool for research or to assist in the design of heat exchangers or other fuel system components. The model contains several unknown parameters that must be "calibrated" using experimental data for a particular fuel. This paper describes the development of the model, a method of "calibrating" the model, and a sensitivity analysis of the effects of different model parameters on predicted deposition rates in a heated tube. 26 refs., 9 figs.

27576 (FRT–80-7-2811) **Application of simple methods for the calculation of liquid-vapour equilibria for forecasting the properties of petroleum fluids. Corrected general cubic equation: examination of methods derived from continuous thermodynamics.** Peneloux, A.; Rauzy, E. Aix-Marseille-2 Univ., 13 - Marseille (France). 1988. 86p. (In French). Order Number DE90773295. Available from NTIS (US Sales Only), PC A05/MF A01.

Liquid vapor equilibria under pressure and volumetric properties of mixtures of petroleum fluids are calculated by methods based on a corrected equation of state, on the corrected equation of Soave - Redlich - Kwong and on the corrected general cubic equation. Correction methods on volumes are detailed.

27577 (NIPER–470) **National Institute for Petroleum and Energy Research quarterly technical report, January 1–March 31, 1990: Volume 1, Fuels research.** National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). 19 Apr 1990. 31p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-83FE60149. Order Number DE90009530. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Fuels research is discussed in the following areas: (1) Department of Analytical Methodology for Analysis of Heavy Crudes; and (2) thermochemistry and thermophysical properties of organic nitrogen-, and diheteroatom-containing compounds. This quarter for project (1), inspection analysis of five 1000°F+ resids employed in the carbonization study were completed. Also, subfractionation of Cerro Negro neutrals fraction was carried out. Progress on Project 2 consisted of: a thermodynamic analysis for the key hydrogen-consuming steps in the hydrodenitrogenation (HDN) reaction network for quinoline; heat-capacity and enthalpy measurements were completed for the diheteroatom-containing compound, thianthrene. Following completion measurements on thianthrene, the heat capacity of the empty calorimeter was determined, and in another calorimeter, heat-capacity and enthalpy studies were started on benzoxazole. Methods to convert benzoxazole to its low-temperature form were developed, and measurements were completed between 80 and 240 K; and high-temperature heat capacities were determined for phenoxathin and carbazole. 1 ref., 14 figs., 11 tabs.

27578 **Hydrous pyrolysis of alkanes, alkenes, alcohols and ethers.** Weres, O., Newton, A.S. (Univ. of California, Berkeley (USA)); Tsao, L. *Organic Geochemistry (UK),* 12(5): 433-444 (1988).

The decomposition reactions of alkanes, alkenes and related compounds have been systematically studied under conditions of

hydrous pyrolysis: 3-5 days at 317C, in the presence of simulated oil filed brine and clay. n-Hexadecane slowly cracks to give n-alkanes and n-alkenes C-2 through C-14. Ethers and alcohols rapidly hydrolyze and dehydrate producing alkenes. Alkenes add to hexadecane to give branched alkanes. Tetrahydronaphthalene inhibits the cracking and alkylation of hexadecane both. n-Hexadecene cracks line n-hexadecane, but a large fraction of it dimerizes. Most though not all reactions observed may be explained in terms of free radical chain mechanisms. For example, there is little evidence for the rearrangement of carbon skeletons, and the distribution of cracking products obtained from squalane is also consistent with a free radical chain reaction. However, the dehydration of alcohols may involve carbonium ions, and extensive migration of double bonds in alkenes was observed. These results demonstrate why alkenes are insignificant in natural oils, while they are commonly present in artificial shale oil. Even at 317C, the rate of alkylation is comparable to the rate of cracking. Because the activation energy for alkylation is smaller than for cracking, the probability of alkylation increases relative to cracking at lower temperature. Therefore, alkylation will be much faster than cracking in petroleum source beds and reservoirs, and the steady state concentration of alkenes will be very small. In the low pressure, high temperature pyrolysis of oil shale a fraction of the alkenes produced boil off together with the alkanes before they are able to react, and appear in the product distillate.

0250 Combustion

Refer also to citation(s) 28274, 28362

27579 Chemical kinetic modeling of combustion of practical hydrocarbon fuels. Westbrook, C.K. (Lawrence Livermore National Lab. Livermore, CA (US)); Pitz, W.J. 14p. Society of Automotive Engineers, Warrendale, PA (USA) (1989). (CONF-8904240--: 40. Society of Automotive Engineers annual earthmoving industry conference, Peoria, IL (USA), 11-13 Apr 1989).

Paper 890990.

The development of detailed chemical kinetic reaction mechanisms for analysis of autoignition and knocking of complex hydrocarbon fuels is described. The wide ranges of temperature and pressure which are encountered by end gases in automobile engine combustion chambers result in extreme demands on the reaction mechanisms intended to describe knocking conditions. The reactions and chemical species which are most important in each temperature and pressure regime are discussed, and the validation of these reaction mechanisms through comparison with idealized experimental results is described. The use of these mechanisms is illustrated through comparisons between computed results and experimental data obtained in actual knocking engines.

03 NATURAL GAS

Refer also to citation(s) 28628

27580 (CGA-CE02953) **Proceedings of the twenty-eighth annual gas measurement school.** Canadian Gas Association, Don Mills, ON (Canada). [1990]. 591p. (CONF-8906313--: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE-02953). Available from Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

Industry deregulation, the Free Trade Agreement, the changing nature of the market place, the growth of exports, and changing technology in the area of gas mesurement have all combined to make gas measurement more important. The tremendous influx of new equipment and methodology in gas measurement is making the task of selecting equipment more complex. This school was organized as a training session for managers and engineers responsible for gas measurement. Major topics covered include automatic meter readings, leak detection, control systems, gas analysis and testing. Separate abstracts have been prepared for 40 papers

27581 (PB-90-160052/XAB) **Research and development results for 1984.** Burnett, W.M.; Edelstein, R.B.; Farrell, M.D.; Gottlieb, M.; Hilyard, J.F. Gas Research Inst., Chicago, IL (USA). Jun 1985. 103p. (GRI-85/7010). Available from NTIS, PC A06/MF A01.

The major technical results and their implications are described for the 1984 GRI R&D programs in End-Use, Operations, Supply Options, and Basic Research. Charts, photographs and schematics are included.

27582 (PB-90-167206/XAB) **Environment and Safety Research Program status report, 1984.** Gas Research Inst., Chicago, IL (USA). 1984. 223p. (GRI-84/7023). Available from NTIS, PC A10/MF A02.

See also report for 1988-89, PB-89-185870.

The status (1984) of activities within the Gas Research Institute's Environment and Safety Research Program are discussed. The project area basis, objectives and goals, accomplishments, and strategies are described for research in supply, utilization, distribution. Contract summary reports are provided for each project area.

27583 (PB-90-167214/XAB) **GRI (Gas Research Institute) basic research program area: Overview and status report.** Gas Research Inst., Chicago, IL (USA). 23 Feb 1979. 32p. (GRI-79/0147). Available from NTIS, PC A03/MF A01.

GRI's Basic Research Program is directed toward addressing basic research problems and advancing basic science in areas related to exploration, production, distribution, and utilization of gaseous fuels. Basic Research objectives are implemented through three subprograms: Chemical Sciences (Kinetics and Catalysis, Thermodynamics, and Molecular Structure - Properties and Processes); Physical Sciences (Materials, Physical Measurements and Evaluation, and Heat and Mass Transfer); and University Grants. The 1979 research projects are described.

27584 (PB-90-167222/XAB) **GRI (Gas Research Institute) Conservation Program: Status report.** Gas Research Inst., Chicago, IL (USA). 13 Dec 1978. 71p. (GRI-78/0057). Available from NTIS, PC A04/MF A01.

The program plan describes the objectives, R&D status, funding levels, and individual projects for the five applications addressed in GRI's Conservation Program: Residential and commercial space conditioning, Gas appliances, Fuel cell energy systems, Industrial utilization, and Solar/gas energy systems. The Conservation Program is designed to accelerate the implementation of higher efficiency gas appliances, equipment and processes to increase the availability of affordable, environmentally acceptable gaseous fuel.

27585 (PB-90-167297/XAB) **Environment and Safety Research status report. 1985-1986.** Gas Research Inst., Chicago, IL (USA). Mar 1986. 159p. (GRI-86/7005). Available from NTIS, PC A08/MF A01.

See also PB-88-210620.

The 1985-1986 status report discusses activities within the Gas Research Institute's Environment and Safety Research Program. These activities are divided into three subprograms: Supply, End-Use, and Operations. The objectives and goals, accomplishments, strategy, project area basis, and contract status are described for each project within these project areas: Natural Gas Supply Environmental and Safety Research, Substitute Natural Gas Supply Environmental and Safety Research, Indoor Air Quality, Combustion Systems Emission Controls, Transport Environmental and Safety Research, and Storage Environmental and Safety Research.

0302 Reserves, Geology, and Exploration

Refer also to citation(s) 27527, 27529

27586 (DOE/MC/21181-1950-Vol.15) **Geological evolution and analysis of confirmed or suspected gas hydrate localities: Volume 15, Evaluation of geological relationships to gas hydrate formation and stability, Summary report: Final report.** Finley, P.D.; Krason, J. Geoexplorers International, Inc., Denver, CO (USA). Nov 1989. 111p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-84MC21181. Order Number

DE90000452. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

We investigated the relationship of geological environments on gas hydrate formation and stability by basin analysis of gas hydrate sites. Basin analyses were performed on 21 offshore locations with direct or indirect evidence of gas hydrates. Extensive geological investigations were conducted for each study region comprising one or more gas hydrate locations. Sediment composition, provenance, and depositional history were documented for each study region. Structural development of the sedimentary basin was determined using drilling results and seismic reflection profiles. Potential for generation of biogenic methane and conventional thermogenic hydrocarbons was assessed by analysis of existing geochemical data and by thermal modeling. All available seismic data, both published and unpublished, were examined for evidence of gas hydrates. Bottom simulating reflectors (BSRs) and other seismic anomalies were mapped. Drilling evidence of possible gas hydrates was reviewed. Based on the limited available information, conditional assessments of gas resources were derived. Quantities of gas contained both in the gas hydrate and possibly trapped beneath the gas hydrate stability zone were estimated. 93 refs., 37 figs., 2 tabs.

27587 (PB–90-151168/XAB) **Technical analysis and program management support of the tight gas sands project area. Annual report, November 1987-October 1988.** Haas, M. ICF Resources, Inc., Fairfax, VA (USA). Dec 1989. 62p. Available from NTIS, PC A04/MF A01.

See also PB–90-151150.

Low permeability (tight) gas formations could provide large supplies of natural gas at reasonable cost in the near term. Properly targeted R&D can resolve uncertainties about geology, extraction, technology and economics. These areas of uncertainty are sufficiently complex and interrelated that a computer-based analysis system is required to assess the costs and benefits of alternative R&D strategies and individual R&D projects. In prior years of GRI funding such a system was constructed and validated. During the current year, the system was applied to solve practical problems associated with R&D planning and resource estimation. While useful to GRI, products from the current work are also directly applicable to industry. Geological studies to define prospective field R&D sites and to add to the knowledge base about the tight sands resource were also concluded during the year. Additional work for GRI will use these results to assist selecting more definitive R&D objectives and a means to quantitatively measure the progress of the Program in meeting its goals.

27588 (PB–90-160466/XAB) **Petrology of Devonian shales: Affects on natural gas production. Topical report, August 1989.** Vessell, R.K.; Davies, D.K. Davies (David K.) and Associates, Kingwood, TX (USA). Aug 1989. 170p. Available from NTIS, PC A08/MF A01.

Color illustrations reproduced in black and white.

Five distinct types of rock occur in the Upper Devonian sequence of the southern Appalachian Basin. Two compositional factors are sufficient to identify all five rock types: the ratio of non-clay minerals to clay minerals and the ratio of kerogen to heavy minerals. Limiting values unique to each rock have been used to develop a model for the wireline log identification of rock types. The rock based log model correctly predicts all five rock types with 82% accuracy. The log model has been used to identify the rock types responsible for gas production in 8 wells with cores and complete log suites. Analysis of this limited data set demonstrates that, the amount of gas produced per perforation is a function of rock type. Natural fracturing is not essential for gas production. However, in documented fractured intervals, there is a substantial increase in the rate of gas production. Approximately one half of the total gas produced is associated with fractured rock.

27589 (PB–90-162199/XAB) **GRI's (Gas Research Institute's) Natural Gas Supply Subprogram status report, 1989.** Gas Research Inst., Chicago, IL (USA). Dec 1989. 120p. (GRI–89/0312). Available from NTIS, PC A06/MF A01.

See also report for 1988, PB–89-161756.

The 1989 status report discusses activities within the GRI Natural Gas Supply subprogram. The objectives, strategies, accomplishments, and contract status are described for projects within these project areas: Tight Gas Sands, Eastern Devonian Gas Shales, Secondary Gas Recovery Technologies, Methane from Coal Deposits, and Advanced Technology for Exploration and Production.

27590 (PB–90-167248/XAB) **Natural Gas Supply Subprogram. Status report, 1985.** Gas Research Inst., Chicago, IL (USA). Dec 1985. 130p. (GRI–85/7016). Available from NTIS, PC A07/MF A01.

See also report for 1987, PB–88-182035.

The 1985 status report contains information on activities within GRI's Natural Gas Supply subprogram. Highlights, objectives, strategies, and contract status are described for these project areas: Tight gas sands, Eastern devonian gas shales, Co-production of gas and water, Methane from coal deposits, and Exploration and production technology.

27591 (PB–90-168238/XAB) **Distribution of natural gas and reservoir properties in the continental crust of the United States. Final report, June 15, 1988-June 15, 1989.** Rice, D.D. Geological Survey, Denver, CO (USA). Oct 1989. 163p. Available from NTIS, PC A08/MF A01.

Analysis of limited drilling and production data and favorable combination of geologic factors indicate that deep gas (>15,000 feet) in U.S. sedimentary basins is an important energy resource. Structural history regulates many of the processes leading to deep gas accumulations. Overlooked sources of deep gas are cracking of C(15+) hydrocarbons in fine-grained rocksand generation from hydrogen-rich kerogen which occurs at high levels of thermal maturity. Although gas, in particular methane, is stable at high levels of thermal maturity, gas quality commonly decreases with increasing thermal maturity. Reservoir properties (porosity and permeability) generally decrease with increasing time-temperature exposure, except where secondary porosity and/or natural fractures are developed. Deep gas accumulations will generally be associated with major fault systems and/or unconformities, commonly are overpressured, and the largest resources will occur in basin center accumulations. U.S. basins established to have the most favorable resource potential for deep gas are the western Gulf, Anadarko, Oermian, Arkoma, Green River, Uinta, and Wind River.

0303 Drilling, Production, and Processing

Refer also to citation(s) 27587, 27588, 27589, 27590

27592 (PB–90-160029/XAB) **Tight gas sands research program: Field operations and analysis. Analysis of selected wells surrounding SFE No. 3, Waskom Cotton Valley Field, Harrison County, Texas. Topical report.** Wolters, B.C.; Robinson, B.M.; Holditch, S.A. Holditch (S.A.) and Associates, Inc., College Station, TX (USA). 27 Dec 1989. 69p. Available from NTIS, PC A04/MF A01.

In preparation for the Gas Research Institute sponsored Staged Field Experiment (SFE) No. 3 in the Waskom Cotton Valley Field of Harrison County, Texas, a comprehensive study was performed on six wells surrounding the site for SFE No. 3. Data from the six wells was provided by Mobil Producing Texas & New Mexico. The data were analyzed using a two-dimensional, single-phase, finite difference reservoir simulator to determine reservoir and fracture properties, which include formation permeability, fracture half-length, fracture conductivity, and reservoir drainage area. The report details the analyses.

27593 (PB–90-169517/XAB) **Summary of data acquisition and field operations: Terra Resources, Anderson Canyon No. 3-17, Lincoln County, Wyoming; Terra Resources, North Anderson Canyon No. 40-16, Sweetwater County, Wyoming. Topical report, August 1989.** CER Corp., Las Vegas, NV (USA). Aug 1989. 51p. Available from NTIS, PC A04/MF A01.

A summary is presented of open-hole data collected on two cooperative wells for the GRI Tight Gas Sands Program. The overall objective of gathering well data in the Frontier Formation is to identify and evaluate technological problems in formation evaluation and hydraulic fracturing. Open-hole data acquisition is emphasized for the Anderson Canyon No. 3-17, a full cooperative well (i.e., coring, logging, cased-hole stress testing, fracture monitoring). Data

collected on the North Anderson Canyon No. 40-16, a partial cooperative well (i.e., logging only), is described in an appendix.

27594 A procedure for relative ranking of sites selected for horizontal wells in tight, naturally fractured reservoirs. Zammerilli, A.M. (U.S. DOE/METC (US)). pp. 550 of Proceedings of the SPE gas technology symposium: Serving a competitive market. Society of Petroleum Engineers, Richardson, TX (USA) (1989). (CONF-890644--: Society of Petroleum Engineers gas technology symposium: gas technology serving a competitive market, Dallas, TX (USA), 7-9 Jun 1989).

SPE 19059.

The relative merits of locating horizontal wells in a naturally fractured shale gas basin are examined in light of controllable and non-controllable factors. This methodology examines non-controllable variables (such as existing reservoir pressure, pay zone thickness, and success ratios) as well as controllable variables (such as gas price and drilling costs) to arrive at the profitability for a horizontal well project in a candidate area. An analysis of the expected monetary value and a cash flow model are used to obtain a distribution of cash flow levels, yielding a determination whether or not a project is likely to succeed. Ranges of profitability for an unstimulated horizontal well are graphically presented. Using this approach, the most likely areas where horizontal drilling can be an economical and technical success are identified.

27595 Partial oxidation reactions of methane and oxygen. Droege, M.W. (Lawrence Livermore Natl. Lab. (US)); Hair, L.M.; Pitz, W.J.; Westbrook, C.K. pp. 550 of Proceedings of the SPE gas technology symposium: Serving a competitive market. Society of Petroleum Engineers, Richardson, TX (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-890644--: Society of Petroleum Engineers gas technology symposium: gas technology serving a competitive market, Dallas, TX (USA), 7-9 Jun 1989).

SPE 19081.

In considering the typical experimental conditions used for studies of methane oxidation to oxygenates or hydrocarbons in the presence of catalysts, it is clear that a significant potential exists for the appearance of non-catalyzed, thermally activated gas-phase reactions of methane and oxygen. Experimentally, in a quartz reactor, significant conversion of methane (30%) to light hydrocarbons and CO_x with appreciable selectivity (25%) to C_2^+ components is observed due solely to these background reactions. In order to identify and describe the contribution of the gas phase processes during catalyzed reactions, a chemical kinetic model (HCT) is employed to describe these homogeneous gas phase reactions. Overall, the model predicts very well the trends and steady state results observed when tested against a series of experimental reactions comparing the effects of various reaction parameters such as residence time, temperature, and gas composition.

0304 Products and By-Products

Refer also to citation(s) 27842

27596 (CONF-891131--, pp. 219-251) **Direct conversion of methane to C_2 and liquid fuels - Chemistry.** Warren, B.K. (Union Carbide Chemicals and Plastics Co. Inc., South Charleston, WV (USA)); Campbell, K.D.; Kinkade, N.E. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC22-87PC79817. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

Union Carbide is interested in developing novel, competitive technology for the conversion of methane to C_2 rich in ethylene. Three unique catalyst systems have been provided which appear to operate by the heterogeneous/homogeneous mechanism, where product distributions are largely dictated by the gas phase chemistry and process conditions. One type of catalyst gives very high ethylene to ethane ratios, and one catalyst appears to be significantly more stable than reported literature catalysts. The third catalyst type, a layered perovskite, exhibits a unique structure and shows performance competitive with literature catalysts. Process studies on the high ethylene to ethane catalysts have included pressure studies and the study of the effect of steam as diluent. Three other catalyst systems were designed in an attempt to change the heterogeneous/homogeneous methane coupling mechanism which is predicted to have a yield barrier. Metals known to activate methane unselectively (i.e., burn methane) at low temperatures were added to good methane coupling catalysts and provide catalysts which exhibit enhanced surface reactions and give yields of 20% to C_2 at lower temperatures. Catalysts which altered the gas phase chemistry were found to result in increased selectivities to C_2 by reduction of the formation of carbon oxides. The results of experiments integrating methane coupling and olefin oligomerization reactions to produce liquid hydrocarbons will be reviewed.

27597 (CONF-891131--, pp. 253-280) **Direct conversion of methane to C_2 and liquid fuels - Process economics.** Matherne, J.L. (Union Carbide Chemicals and Plastics Co. Inc., South Charleston, WV (USA)); Culp, G.L. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC22-87PC79817. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

This report describes the final results of the engineering portion of Union Carbides two-year contract. Economic results from studies of actual and hypothetical cases for the conversion of methane to C_2 will be presented. Economics for the best process configuration were based on laboratory results using a $BaCO_3/Al_2O_3$/ethyl chloride catalyst with a methane/oxygen feed ratio of 7/1, a reactor temperature of 725°C, a methane conversion of 18.4%, and a selectivity to C_2 of 76.7%. It was assumed that the ethylene/ethane production ratio would be 3/1, that co-product ethane would be cracked to ethylene, and that the reactor pressure was 50 psig. Important process variables studied included selectivity to C_2, methane conversion, reactor diluents, methane/oxygen feed ratio, co-feed versus sequential mode, fixed-bed versus fluidized-bed reactors, ethylene/ethane production ratio, the fate of co-product ethane (crack versus sell), reactor pressure, and reactor temperature. For both nitrogen and steam dilution cases, the economics improve with increasing methane/oxygen feed ratio, which increases selectivity to C_2 at the expense of lower methane conversion. The methane dilution case is favored economically over any of the nitrogen and steam dilution cases, due to the higher selectivity to C_2.

27598 (CONF-891131--, pp. 281-286) **C_1 catalysis at IGT (Institute of Gas Technology).** Lee, A.L. (Institute of Gas Technology, Chicago, IL (USA)); Erekson, E.; Barone, S.P. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

The purpose of this research is to develop catalysts and processes to produce high value chemicals using natural gas directly as a feedstock. The study found that when a mixed basic metal oxide is promoted by another metal oxide with a higher oxidation state, there is an increase in the catalyst basicity. Sixty different catalyst formulations were tested and some of the representative results are summarized.

27599 (CONF-891131--, pp. 287) **Direct conversion of methane to higher hydrocarbons through oxidative coupling.** Smith, K.J. (Alberta Research Council, Devon (Canada)); Painter, T.; Galuszka, J.Z. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

The Alberta Research Council and Energy, Mines and Resources, Canada (CANMET) are currently pursuing a jointly funded research program aimed at upgrading methane to higher hydrocarbons via oxidative coupling. The major objective of this work is to investigate the use of a range of supports, metal oxides and promoters as catalysts for the oxidative coupling reaction, to optimize the formulation of the most promising catalyst and to determine the effect of process variables on catalyst performance. As part of this program, a comparative study on the performance of Sn, Bi and Pb oxides, supported on CaO, MgO and NaY zeolite, and promoted with La, Li and K, has been performed. The catalysts were

tested at 101 kPa and 750°C in a fixed bed, quartz reactor, operated with the CH4 and 02 fed to the reactor in a cycling mode. The catalysts were characterized by ESCA, XRD and surface area analysis. For the catalysts supported on CaO, the C2 yield decreased in the order Pb > Bi > Sn, with the PbO/CaO catalyst having a C2 yield of 12.3%. For the 20% PbO supported on NaY zeolite, CaO and MgO, the C2 yield decreased in the order CaO > MgO > NaY, whereas the C2 selectivity decreased in the order NaY > CaO > MgO. It is also shown that promoting the catalysts with La, Li and K has a positive effect on C2 yield and that for the PbO/CaO system, the promoter appears to reduce the loss of PbO from the catalyst surface. These observations are discussed in terms of the XRD, ESCA and surface area analyses and in terms of observations reported in the literature on similar catalysts. Directions of future work will also be highlighted.

27600 (CONF-891131–, pp. 289-328) **Natural gas to liquids conversion technology status - An overview.** Malone, R.D. (Morgantown Energy Technology Center, WV (USA)); Komar, C.A.; Headley, L.C. USDOE Pittsburgh Energy Technology Center, PA (USA). [1989]. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

The paper provides a summary of technology currently available to convert methane gas into high liquid hydrocarbon forms. This research is ongoing and has progressed to include research in catalytic, noncatalytic, and biological conversion processes. The paper also provide an economic and technological comparison between the various conversion processes.

0305 Health and Safety

Refer also to citation(s) 27566, 27617, 27633

0306 Economic, Industrial, and Business Aspects

Refer also to citation(s) 27587, 27597, 27626, 28123, 28947

27601 (CGA–CE02953, pp. 166-172) **Providing electronic volume signals to customers.** Brown, J.F. (Union Gas Ltd., Chatham, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

Union Gas has seen a growing number of requests from customer for electronic access to metering information. The development of a number of electronic volume integrators and data acquisition systems has provided Union the ability to satisfy these customer requests. The approach taken by Union to meet these requests is the subject of this paper. One of the basic tenets of Union's philosophy regarding the provision of electronic volume signals to customers is that customers are permitted access to electronic signals proportional to volume. However, it was felt necessary that for safety reasons that customers not be permitted to attach their own equipment directly to meters and station piping. Thus, Union owns and operates all equipment attached to its meters and piping systems. Customers are provided electronic signals only. It was decided that only standard packages would be made available to customers as follows: electronic volume integrators, Metretek System and uncorrected volume/pressure/temperature signals. Customers are required to pay incremental costs associated with providing the signal. A written agreement is executed between Union Gas and the customer on the provision of signal and the costs. This new service requires that additional records be kept by the utilities, and additional operating and sales personnel be hired and trained. Customers sometimes require advice and assistance on using the information which is available.

27602 (CGA–CE02953, pp. 102-122) **Load research: End use analysis and applications.** Carothers, C. (Consumers Gas Co. Ltd., Scarborough, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

This report summarizes the results of load analysis based on a sample of residential customers using natural gas for space heating and water heating, whether with or without other uses, and identifies some of the benefits derived from this added market knowledge. Load research is the process of measuring and analyzing the load characteristics of end uses within the utilities franchise area, with the objective of quantifying the load (demand) attributes. Currently, most gas utilities' residential and general service volumetric data are restricted to monthly or bimonthly meter readings. This aggregate data forces the use of numerous assumptions related to the end uses' load attributes such as, load factor, the level of seasonality, the magnitude of homogeneity, and each of the end uses contribution to consolidated (total) consumption. To measure these characteristics it was necessary to monitor disaggregated demand. The monitoring configuration allowed for metering separately central heating, automatic water heating, and any combined other uses. The data recorder stored readings by end use in 15 minute intervals for one full year. This permitted the precise quantification of specific loads. These measurements can assist in setting rates, marketing, load management, system design, load forecasting and system measurement. 6 refs., 10 figs., 9 tabs.

27603 (CGA–CE02953, pp. 248-255) **Audit procedures: Orifice metering.** Barnes, M. (Western Gas Marketing Ltd., Calgary, AB (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

One of Western Gas Marketing's gas measurement group's objectives is to ensure that all gas we purchase is measured accurately and that all volumes are determined and reported correctly. This paper describes the auditing procedures for orifice metered facilities. An audit involves the collection of several kinds of information. A facility report describes the facilities location, equipment and its gas sampling schedule. A review of any gas volume estimates used by the facility is included. The facility operator provides daily reports of gas volume usage during the audit period. This information is compared with the facility's meter measured gas usage. A series of gas analysis reports from the facility provides information on the gas gravity, heating value, and levels of N_2 and CO_2. Also renewed are orifice meter inspection reports contain data from monthly inspections carried out by the facility. These reports provide valuably history on performance and maintenance. Similar reports are collected on the gravitometer and the calorimeter. Gas volume statements and daily measured gas reports are reviewed for missing data or extraordinary events.

27604 (CGA–CE02953, pp. 205-213) **Metretek PC utility network system 4.** Wright, R. (Metretek Inc., Melbourne, FL (USA)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

Over the past several years, there has been an ever increasing number of gas and electric utilities using the Metretek Data Collection System for monitioring customer energy usage. The applications involved have ranged from monitoring city gate stations and large industrial users through residential automatic meter reading. The vast majority of these utilities have used the Metretek PC Utility Software System, wehich is based on IBM PC or compatible computers, to collect this metering information. Although this system is quite adequate for most requirements, the system has several built-in limitations which restrict the ultimate large-scale use of the sytem. Accordingly, Metretek has developed an expanded version of this same software system called the PC Utility Network System 4. This paper reviews the capabilities of the new Network system. Metretek's PC Utility Network System 4 provides a means

for larger Metretek users to support significantly more remote units while allowing several departmental users to access the data collected simultaneously. With the Network System several thousand remote units can be processed on a very rapid basis. The use of the collected data can be expanded to many departments within the utility. Each department can generate reports pertinent to their needs. The system allow integration of data collection and billing.

27605 (CGA–CE02953, pp. 393-409) **Automated meter reading - large volume customers.** Louie, D. (Canadian Western Natural Gas Co., Calgary, AB (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

Canadian Western is a natural gas utility based in Calgary, Alberta which is involved in the production, transmission and distribution of natural gas in the southern region of Alberta. AMR (automated meter reading) has generated a great deal of interest in the industry in recent years. This paper discusses Canadian Western's AMR program: how the decision to proceed was arrived at, what the program is in terms of scope and objectives and how it went about selecting the AMR system to meet those objectives. This paper concentrates on experience with large volume users, principally industrial/transportation installations. A typical AMR installation consists of an electronic volume indicator and a communications device. These installations are characterized by high pressure metering where pressure and temperature data are required, data usually includes corrected and uncorrected volume. Three different software packages were chosen for use in sites with different equipment and information needs. All systems communicate by telephone; one has both call-in and call-our capabilities while the others are used mainly as call-out systems. Two of the systems are currently installed and are meeting initial objectives. 1 fig., 1 tab.

27606 (CGA–CE02953, pp. 365-371) **Moisture content: Policy, effects and operation.** Gray, A. (Union Gas Ltd., Chatham, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

With an increased awareness, especially from customers, about gas quality including water vapour content, Union Gas has reviewed and developed a policy on water vapour content in the gas that it handles. The policy allows delivery of gas with water vapour contents up to 5 lbs./mmcf. However production into the system is allowed up to 14 lbs./mmcf. if some conditions are met. To develop, implement and enforce such a policy required that the existing conditions be assessed, that monies be spent, that monitoring be done and, above all, that all involved parties be educated to understand and appreciate the equipment, rationale and details of the policy. Union Gas has a large number of industrial customers which are highly concerned with gas quality. Gas is purchased from a number of sources and there are legislative constraints on the amount of moisture allowable. A gas dehydration system has been installed and gas quality is now monitored closely at gas input points, some main gate stations, regulator stations and at some customer's locations.

27607 (CGA–CE02953, pp. 481-489) **Application of PCs in meter proving.** Tang, P.W. (BC Gas Inc., Vancouver, BC (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

This paper describes a design approach used by BC Gas to implement an intergrated gas meter proving and record keeping system. This method emphasizes the use of standard off-the-shelf personal computers (PCs) and accessories for controlling prover test benches, analyzing test data, displaying test results to and receiving instructions from the prover and sending test results to a central work station for statistical calculations and data archiving. Based on information supplied by the equipment user and the maintenance personnel, the following design criteria was established for the new prover system: good machine/operator interface was emphasized; a bar code reader was used for checking-in meters; each prover station was to be operating alone; and would have a local data storage device; each prover station would be capable of down-loading test data to a central computer: the system would generate clear diagnostic messages to help the operator or maintenance personnel identify and solve problems; and the system would use as much off-the-shelf hardware as possible to ensure future supply of spare parts. The system would use a standard high level programming language to facilitate software maintenance and future system upgrading. BC Gas has operated a test PC based prover station for the last two years. Feedback from the operating and maintenance personnel indicate that the prover station is living up to the design expectations. The PC offers a reliable, low cost, and yet very powerful method for running the conventional bell provers. 4 figs.

27608 (CGA–CE02953, pp. 448-454) **Meter shop accreditation.** Kent, D.W. (Union Gas Ltd., Chatham, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

Prior to the summer of 1986 Union Gas had invested resources in a program directed at improving meter quality. One of the reasons for this investment was that in late 1984 a decision was made to discontinue the practice of repairing domestic meters. In conjunction with this decision, it was recognized that it was necessary that the new meters installed should have as long a life as possible. It was through that by ensuring that only highly accurate new meters were installed, the meter life could be extended. For this reason, modifications were made to the meter proving facility to enhance meter testing accuracy. Three basic modifications were made. These were: improvement of temperature control, 100% in-testing, and automation of provers. This paper describes the activities at Union Gas Between the fall of 1986 and the spring of 1989 that were directed towards accreditation. These activities resulted in achieving accredited meter verifier status for new meters in April of 1988 and for seal extension meters in June of 1989. 3 tabs.

27609 (CGA–CE02953, pp. 490-497) **A new low-cost volume, pressure and temperature automatic monitoring device.** Mahoney, W. (Metscan Inc., Honeoye Falls, NY (USA)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

This paper describes the VTP, a new low-cost automatic monitoring device (AMD) currently under development at Metscan which will be capable of monitoring gas volume, pressure and temperature. The VPT is a Microprocessor controlled device that controls an uncorrected gas meter input and collects data that will allow this gas volume to be corrected for pressure and temperature variances from standard values. The VPT will accumulate interval usage data as well as pressure and temperature data and send it to the data collection computer (DCC). DCC software will provide full consumption, pressure, and temperature reporting over time, plus analysis. The VPT can optionally send its data via a directly connected telephone line, or to a telephone line connection made by a radio frequency add-on module. The radio frequency (RF) module forwards data through the telephone network to the DCC. All communications, whether direct connect or RF-connected, will be managed identically to the rest of the Metscan family of automatic monitoring devices. The current Metscan Master and

node-level DCC's will control, communicate with, and provide reports and analysis from VPT's - VPT devices will be available in volume in October 1989.

27610 (GRI–90009778) **The long-term trends in US gas supply and prices: The 1989 GRI baseline projection of US energy supply and demand to 2010.** Woods, T.J. Gas Research Inst., Chicago, IL (USA). Strategic Planning and Analysis Div. Mar 1990. 50p. Sponsored by Gas Research Institute. Available from OSTI; Gas Research Institute, 8600 West Bryn Mawr Avenue, Chicago, IL 60631.

The report summarizes the gas supply outlook in the 1989 GRI Baseline Projection of US Energy Supply and Demand, which has been adopted as a major input to the planning cycle leading to the development of Gas Research Institute's (GRI) 1991 research and development program. The 1989 projection presents the GRI planning outlook for the economic and the energy supply and demand situation to the year 2010. The 1989 GRI Baseline Projection describes a world with substantially lower energy prices than previous GRI projections. As a result of these lower prices, the demand for energy, including gas, is much higher. By the year 2010, gas consumption has increased to almost 21 quads. Despite the lower prices, the 1989 projection shows that gas supply can increase to meet this demand at competitive prices. 26 refs., 4 figs., 21 tabs.

27611 (PB–90-159591/XAB) **Competitive position of natural gas: Industrial drying. May 1988.** Gas Research Inst., Chicago, IL (USA). May 1988. 9p. (GRI–88/0021.1). Available from NTIS, PC A02/MF A01.

See also PB–88-188883 and PB–88-196399.

The summary provides the results of studies performed to better understand the factors that affect the use of natural gas technologies in industrial drying applications and to identify potential R&D. The studies indicate that while many gas markets in industrial drying face competition from new steam and electric technologies, gas technologies under development can potentially maintain the effectiveness of natural gas and open new markets.

27612 (PB–90-159732/XAB) **Outlook for total energy and natural gas demand in the industrial sector. Topical report.** Hogan, T. Energy and Environmental Analysis, Inc., Arlington, VA (USA). Apr 1989. 134p. Available from NTIS, PC A07/MF A01.

The study provides information on industrial energy use, detailed by technology, functional end-use, industry and region. Industrial energy intensity trends are projected to continue to decline at a rate that is higher than the pre-embargo period, but lower than the post-embargo period. The mix of functional natural gas demand is projected to increase and will maintain market share in all aggregate end-use applications. Appendixes include a comparison of GRI and Industrial Sector Technology Use Model (ISTUM-2) energy demand projects; a discussion of the feasibility of fuel substitution in industrial combustors; input assumptions; and ISTUM-2 projections.

27613 (PB–90-159799/XAB) **Baseline projection data book: 1988 GRI (Gas Research Institute) baseline projection of US energy supply and demand to 2010.** Ashby, A.B.; Holtberg, P.D.; Lihn, M.L.; Woods, T.J. Gas Research Inst., Washington, DC (USA). Strategic Analysis and Energy Forecasting Div. Dec 1988. 495p. (GRI–88/0346). Available from NTIS, PC A21/MF A03.

See also PB–88-145354.

The 1988 baseline projection data book provides backup data in tabular form for the 1988 GRI baseline projection of U.S. energy supply and demand in 2010. Data are included for the residential, commercial, industrial, electric utility, and transportation sectors; gas supply and prices; and energy prices. Summary tables are provided.

27614 (PB–90-162173/XAB) **Policy implications of the GRI (Gas Research Institute) baseline projection of US energy supply and demand to 2010, 1989.** Gas Research Inst., Chicago, IL (USA). Dec 1989. 17p. (GRI–89/0310). Available from NTIS, PC A03/MF A01.

See also PB–89-138622.

The 1989 GRI Baseline Projection of U.S. Energy Supply and Demand is summarized. Three broad policy implications are highlighted: the consequences and relative long-term stability of a low oil price track, the increasing probability of a shortfall in required central-station electric generating capacity in the 1990s, and the growing importance of environmental concerns as a driver in developing national energy policy.

27615 (PB–90-167271/XAB) **High-temperature industrial process heating: Oxygen-gas combustion and plasma-heating systems. Topical report.** Williams, S.J.; Cuervo, L.A.; Chapman, M.A. RCG/Hagler, Bailly, Inc., Washington, DC (USA). Jul 1989. 361p. Available from NTIS, PC A16/MF A02.

See also PB–90-167289. Portions of this document are not fully legible.

Direct-fired process heating in the manufacturing sector of industry is one of the largest energy and natural gas consuming markets. The market embraces a wide variety of process heating technologies, temperatures, fuels, and site-specific energy requirements. While natural gas-based technologies are used extensively in low-temperature heating, they account for a smaller share of the high-temperature applications, where coal, electricity, and waste fuels are more widely used. Advanced gas technologies will be required for natural gas to maintain its competitive position in high-temperature heating. The study assessed the future competitive position of various high-temperature heating technologies. Its results help project the potential ability of these technologies to optimize least-cost energy service in key direct-fired heating applications. The market potential of these technologies, along with their current R&D status, are reviewed to highlight implications for future R&D efforts.

27616 (PB–90-167289/XAB) **Low-temperature industrial process heating: Radiant, pulse, and catalytic combustion systems. Topical report.** Williams, S.J.; Chapman, M.A.; Cuervo, L.A. RCG/Hagler, Bailly, Inc., Washington, DC (USA). May 1989. 363p. Available from NTIS, PC A16/MF A02.

See also PB–90-167271. Portions of this document are not fully legible.

Direct-fired process heating in the manufacturing sector of industry is one of the largest energy and natural gas consuming markets. The market embraces a wide variety of process heating technologies, temperatures, fuels, and site-specific energy requirements. While natural gas-based technologies have dominated this market, non-gas technologies have become widely applied. Advanced gas technologies may be required if natural gas is to retain a competitive advantage in providing least-cost energy service. The study evaluates the technical status of various advanced gas burner technologies. It assesses the potential ability of these technologies to maintain the competitive position of natural gas in key direct-fired heating applications. The market potential of these technologies, along with the current development status, are reviewed to highlight research implications.

0308 Environmental Aspects

Refer also to citation(s) 27563, 27566, 27572, 29039

27617 (PB–90-158908/XAB) **Environment and Safety research status report: 1984-1985.** Gas Research Inst., Chicago, IL (USA). Mar 1985. 154p. (GRI–85/7003). Available from NTIS, PC A08/MF A01.

The status of research activities in GRI's Environment and Safety Research program are described: Supply (Unconventional Natural Gas Environmental Research, Gasification Environmental and Safety Research, and Biomass and Wastes Environmental Research); Utilization (Indoor Air Quality, and Industrial Emission Control); and Distribution (Distribution Environmental Research, Liquefied Natural Gas Safety, and Distribution Safety). The objectives, goals, accomplishments and strategy, along with the basis for each project area, are presented. A status review sheet is included for projects within each project area.

0320 Transport, Handling, and Storage

Refer also to citation(s) 27602, 28886, 28944, 28945, 28946, 28948, 28950, 28951

27618 (CGA–CE02953, pp. 72-101) **Primary device research: Meter tube roughness effects on orifice metering.** Studzinski, W. (NOVA HUSKY Research Corp., Calgary, AB (Canada)); Berg, D.H.; Bell, D.G.; Gagnon, D.J. Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

The objective of this paper are to present preliminary results of the effects of meter run roughness in orifice metering, provide a theoretical base which explains the effects of relative roughness on the velocity profile, and conduct a review of previous work done in this area. Tests were carried out at NOVA's high pressure natural gas test facility using industrial type orifice meters that were assembled with commercial pipe, flanges and orifice fittings. Two 102 mm orifice meters were installed in series, apart, and the relative change in flow rate was measured for a given configuration. Surface roughness of meter tubes, flanges and fittings ranged between 1.0 and 11.2 μm. standard deviation of the flow rate difference between the orifice meters did not exceed $\pm$0.15%. Preliminary results showed effects, for the meter run roughness tested, only at a beta ratio of 0.74. For the extreme case, the orifice meter readings differed by $\pm$0.60%. The most interesting results were obtained for a step change in the meter run roughness in the vicinity of the orifice plate where different readings were obtained depending on the location and magnitude of the surface roughness. Preliminary findings indicate that an increase of meter run roughness results in higher orifice discharge coefficients and flow meter under-registration. Also, it appears more attention should be given to the surface roughness of orifice fittings located immediatewly upstream of the orifice plate. 12 refs., 11 figs., 2 tabs.

27619 (CGA–CE02953, pp. 27-36) **Gas measurement and other research areas at Canadian Gas Research Institute.** Farkas, E.J. (Canadian Gas Research Inst., Don Mills, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

The Canadian Gas Research Institute, CGRI, is a private, not-for-profit research institute supported by 22 member companies across Canada. Personnel from these companies sit on a research management committee, which determines research and development priorities for CGRI. This paper discusses research on gas measurement and other areas at CGRI. Other research areas include, odourant concentration measurement, residential equipment, and oxygen enrichment. CGRI was involved in a five year project to develop a dispenser for vehicles powered by natural gas. CGRI developed a design for an improved filling probe and vehicle receptable. Multiple examples of the CGRI probe/receptacle system were manufactured. The CGRI design is available in two sizes, one for passenger cars and light vehicles and one for transit buses. 1 fig.

27620 (CGA–CE02953, pp. 59-71) **Fundamentals of gas measurement: Overview of gas measurement covering types, operation, sizing and selection.** Hassard, K. (Canadian Meter Co. Inc., Milton, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eight annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

This paper gives an overview of gas measurement which includes the four basic types of gas meters presently in use in Canada, namely, diaphragm, rotary, turbine and orifice, covering their basic principles of operation, sizing and selection. These orifices are discussed in generic terms as much as possible, since several manufacturers are involved in the supply of the 3 major types of meters in Canada. Comments relate to practival experience at Canadian Meter, and gas meters manufactures are identified in this paper. Discussion on each type of meter includes a description of its operation, its typical applications, its capacity and calibration methods. Virtually all gas measurement in North America is made by one of the four types of meters discussed. Generally speaking, the capacity of these meters are as follows: diaphram (positive displacement) 1/100 to 10,000 cubic feet/hour (CFH), rotary (positive displacement) 800-100,000 CFH; turbine (inferential) 800-150,000 CFH; orifice (inferential) 200-100,000 CFH.

27621 (CGA–CE02953, pp. 37-58) **Pneumatic and digital controllers.** Jong, F. de (Fisher Controls Co. of Canada, Woodstock, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

Gas meter controllers are sometimes called pilots, but there are a number of significant differences between the contoller and the conventional regulator pilot. In comparison, the controller has much better frequency response and general dynamic characteristics than the conventional pilot. The controller typically has very high gain in comparison to the low fixed gain pilot. In addition, the pilot operates strictly on the simple proportional modes whereas the controller frequently operates with two additional modes called reset and rate. In short, the controller has a number of adjustments that gives it operating flexibility the pilot does not have. On the other hand, because of this flexibility it is important the controller be adjusted and used properly for optimum performance. This requires a thorough understanding of some fundamental relationships that will be explored in this paper. 25 figs.

27622 (CGA–CE02953, pp. 181-185) **Fundamental principles of pilot operated regulators.** Jong, F. de (Fisher Controls Co. of Canada Ltd., Woodstock, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

Regulators used by the gas industry are either self operated or pilot operated. An example of a self operated regulator is a spring opened valve directly opposed by a diaphragm assembly. Gas, at increasing downstream pressure, acts on the diaphragm assembly to overcome the force of the spring, closing the valve. When downstream pressure falls, spring force is greater than the force of the gas acting on the diaphragm, and the valve opens. The service type regulator is a variation of the self operated regulator. It operates the same as the simple self operated regulator, except that a lever is used to gain mechanical advantage and provide a high shutoff force. A Pilot operated regulator has the ability to multipy a small change in the downstream pressure into a large change in pressure. These types of regulators control pressure as the self operated, but without some of the limitations. This paper discusses both types of regulators in detail, along with their advantages and disadvantages. 8 figs.

27623 (CGA–CE02953, pp. 173-176) **Mercury instruments electronic corrector.** Holmes, J. (Mercury Instruments Inc., Cincinnati, OH (USA)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

The Mercor EC is a battery-powered, fully-configurable, microprocessor-based volume corrector, installed on the instrument mounting facility of turbine meters, diaphragm meters and rotary meters. Pressure may be absolute or gauge, and is measured by an integral strain-gauge transducer. Temperature is measured by a precision thermistor sensor in the end of 1/4 inch insertion probe

with the leads protected by stainless steel armour. Pressure, temperature and volume are displayed in a variety of selectable, scalable units. Supercompressibility is a dynamic function of measure pressure, temperature and of programmed values of specific gravity, mol% N2 and mol% CO2, in conformity to AGA-3 and NX-19. These and other variables plus alarms are viewed on an 8-digit numeric display, with legends and units appearing on a smaller 16-digit alphanumeric display. Up to twelve selected variables can be read with the instrument door closed by means of a magnet actuator. A mechanical index permits verification of the uncorrected volume total which is internally sensed by redundant input switches. Output pulsers provide external communication of corrected and uncorrected volume.

27624 (CGA–CE02953, pp. 155-165) **Electronic metering signals for large volume gas consumers.** Tylians, T.M. (ICG Utilities (Ontario) Ltd., North Bay, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

This paper discusses the approach taken by ICG Utilities (Ontario) Limited to satisfy the needs of its large volume gas consumers who are requesting some sort of metering signal. There are a multitude of different types of signals that can be requested by the various customers. It was decided to prepare a standard questionnaire that could be used by the Industrial Gas Utilization Department to document the customer's requests. The procedures, as outlined in this paper, are used to determine the customer's requirements, purchase the necessary equipment and reach an agreement covering the customer's and Gas Company's responsibilities. The purpose of this questionnaire was to gather information about the customer's information needs, existing metering equipment, data gathering technology, interface requirements and the physical environment of the metering system. The customer is provided with detailed cost estimates based on information in the questionnaire. The AMS installation procedure is described in some detail including the safety techniques used in installing electrical components in hazardous areas. The questionnaire used with customers in included. 3 figs.

27625 (CGA–CE02953, pp. 145-154) **Generic automatic meter reading.** Caveny, T. (Northwestern Utilities Ltd., Edmonton, AB (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

AMR or automated meter reading occurs when the customers meter is read and recorded via electroic means without the use of a human meter reader. The purpose of this paper is to provide some of the information required to select an automatic meter reading (AMR) system. The selection process requires a basic knowledge of how information can be transfered to the central office. One system may suffice or several systems may be needed depending on customer's relationships with other utilities and other factors. Included is a discussion of communications systems which may be used with AMR and factors to be considered when selecting an AMR system. Communications modes which may be used with AMR include cable TV, telephone, radio-wave systems and power line carriers. The major advantage of the cable TV system is its ability to provide meter readings on demand, the major disadvantage is the low saturation of cable sources. The major advantage of the use of power line carriers is the almost complete saturation of power services, disadvantages include a high cost of installation and open ended system charges. There are two possibilities for telephone based systems; with the call-outbound system the remote meter reading is provided as a result of a call originating at a central location, with the call-inbound system, the meter is programmed to call in the meter reading at preselected intervals. Radio based systems broadcast meter readings on demand to a stationary or mobile receiver. Radio systems have low installation costs and high operating costs.

27626 (CGA–CE02953, pp. 123-133) **Schlumberger automatic meter reading and billing system.** Price, A. (Schlumberger Industries, Mississauga, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

The field of automatic and remote meter reading (AMR) systems is constantly evolving, driven by a variety of conditions and technologies, while trying to provide a product that best suits the utility customer's needs. This paper covers the technical aspects of automatic meter reading systems, then provides an outline of the forces and conditions contributing to the emergence of Schlumberger's automatic meter reading technologies. It concludes with an analysis of some of the economics involved in the justification of AMR. AMR systems permit a utility to gather its meter reading information at a central location without physically visiting the meter site. These systems may communicate with the central station via telephone lines, via cable television based lines, via a radio frequency transceiver located at the meter site, or via power lines. The choice of a system will depend on: available communications networks; number and types of meters to be read; geographical distribution of meters; and performance requirements of the system. AMR reading has the following advantages: it overcomes access problems; it reduces or eliminates bill estimation leading to improved customer relationships and better resource management; and it makes possible a faster billing cycle, and give the utility customer a better tool with which to manage their system resources. 5 refs., 1 figs.

27627 (CGA–CE02953, pp. 231-247) **Fundamentals of overpressure protection.** Quinn, D. (Union Gas Ltd., Chathan, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

Overpressure protection ensures that a defined maximum pressure for a system is not exceeded. Pressure is relieved by isolating the source of excess pressure or venting the excess gas to atmosphere. The maximum allowable operating pressure (MAOP) of the system is defined by: pressure holding capability of pipe and fittings, pressure rating of operating equipment on a system, and the design pressure of the stations on the systems. Once this pressure is defined, the type, size, and quality of the overpressure protection can be selected. The starting point of any evaluation of overpressure protection should start with a review of Canadian Standards Association CAN/CSA-Z184-M86 Gas Pipeline systems Code. After review of the guidelines, the types of overpressure protection, their operation and some criteria for their use will be discussed. Relief valves, valves which simply evacuate gas from an overpressured sytem, are the main kind of overpressure protection. Internal relief valves, commonly used in residences and small commercial/industrial systems, have a small release spring which is part of the linkage system of the regulator. When the diaphragm of the regulator moves past a maximum position the internal relief spring allows gas to escape. Spring operated relief valves suitable for larger systems, operate independantly from the regulator. Gas is released when internal pressure exceeds a pre-set level. The release pressure can be set by the operator. Pilot-operated relief valves use a small regulator (the pilot) to unload pressure from above a pressure measuring device. This type of valve allows better control of pressure than spring operated valves. 8 figs.

27628 (CGA–CE02953, pp. 214-230) **Improved accuracy with orifice meters.** Knoll, F. (Daniel Industries Inc., Calgary, AB (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from.

Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

This paper discusses the advantages of orifice metering and methods of optimizing their performance. Major advantages include the following: long life, low maintenance costs, low cost, wide acceptance, ease of installation, availability of large amounts of historical data, high reliability, no prover required, and it can handle most fluids including dirty fluids. It is simple to use, requires no lubrication, and maintenance is very easy. Various means of optimizing orifice meters are described. These include: choosing the right application (situations with turbulent gas flows are unsuitable); implementing measures for reducing turbulence in orifice meter tubes; conscientious maintenance of orifice plates, proper sizing; adherance to rangeability limits; use of smart transmitters and computerized read-out devices; and accurate measurement of gas pressure, temperature, and density.

27629 (CGA–CE02953, pp. 343-350) **Electronic test equipment.** Barker, D.S. (Union Gas Ltd., Chatham, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

As electronics become an intergral part of the measurement of natural gas, the selection of electronic test equipment becomes increasingly important. In addition, with the increased complexity of the electronic equipment at the station, the sophistication of the test equipment is being greatly increased. This paper points out pitfalls frequently ecountered when selecting calibration equipment and indicates differing criteria when selecting equipment for calibration as opposed to maintenance. Problems discussed include resolution, accuracy, linearity, and relative humidity. Manufacturers specifications are often presentation oriented and do not give the kind of information needed to make a decision. The following capabilities have high priority when electronic equipment is to be used for calibration: resolution, accuracy, linearity of readings, hysterysis, temperature coefficient, temperature range, stability, common mode vase rejection effects of shock and vibration, and the sensitivity to relative humidity. When purchasing for maintenance and repair; operational accuracy and resolution are much less important.

27630 (CGA–CE02953, pp. 410-424) **Gas detection - past and future.** Hennigan, G.W. (Health Consultants Ltd., London, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

This paper traces the history of the natural gas industry as well as the development of instrumentation for gas leakage detection. The current status of various types of gas detection instrumentation is discussed along with comments in regards to new developments in the next decade. Flame ionization instruments along with visual observation have been the standard method of leak detection since the mid 60's. During the 80's semiconductor leak detectors have received some acceptance for household leak detection. The ultimate leak detector for remote areas would involve overflight detection. Some success has been achieved with infrared systems and there is a great deal of interest in laser systems. Sonic detection technology has severe limitations which will probably make it unusable in the gas industry. Various types of internal leak detectors have been developed for use with gas and liquid transmission lines. Computer-based systems are being used in the transportations of hazardous substances. The development of the Gasurveyor line of instruments, their current status and their impact on industry safety through the 1990's are also discussed. Comments are presented on the second generation of Gasurveyors that will make their debut in early 1990. 4 refs.

27631 (CGA–CE02953, pp. 498-525) **Developments in the proving room.** Poole, J. (Canadian Meter Co., Milton, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

This paper documents work done at Canadian Meter Inc. to improve the quality of proving room performance. The objectives of this program were to increase productivity and to reduce the number of provers in use. This reduction was expected to enable the use of fewer provers and reduce the need for maintenance. A microprocessor was developed to collect data directly, upload it into a computer in real time and analyze the data. This system was installed and tested and is currently producing highly repeatable results. A sonic nozzle prover was also evaluated. This prover promises several advantages including: direct transfer of reference volume, higher productivity, less maintenance of mechanical parts, ensured correct flow rate; and increased tolerance of small temperature differences. 3 figs., 2 tabs.

27632 (CGA–CE02953, pp. 546-588) **The API/GPA experimental data base.** Gallagher, J. (Shell Oil Co., Houston, TX (USA)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

An experimental data base has been developed for concentric, square-edged, flange-tapped orifice meters in undisturbed flow conditions. The data base, generated from experiments sponsored by the American Petroleum Institute (API) and the Gas Processors' Association (GPA), consists of two data sets - regression quality and comparison. The experiments were conducted over a five year period at three laboratories using separate test fluids - oil, water and natural gas. A fractional factorial experimental pattern was selected to vary pipe diameter, Beta ratio and pipe Reynolds number over a range sufficient to allow utilization of Reynolds law of similarity. The pattern covered five nominal pipe diameters, eight nominal beta ratios and Reyolds numbers ranging from 100 to 10,000,000. During this same period, the Commission of European Communities (CEC) was sponsoring similar experiments in Europe. The CEC pattern covered two nominal pipe diameters, six nominal Beta ratios and Reynolds numbers ranging from 4,000 to 35,000,000. The CEC base also consists of two data sets - regression quality and comparison. The API/GPA and CEC Data Bases were combined by international metering experts to assemble a regression data set. The data set consists of 10,192 points from eleven different laboratories, using four fluids with different sources, on twelve different meter tubes of differing origins, using over one-hundred orifice plates of differing origins. The final outcome later this year will be a new equation to predict the orifice meter's discharge coefficient for newtonian fluids in the petroleum, chemical and natural gas industries. 14 refs., 25 figs., 1 tab.

27633 (CGA–CE02953, pp. 526-545) **Station design: An overview of the basics of meter station design.** Grant, B.A. (Union Gas Ltd., Chatham, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

A meter station, as the cash register of the Company, not only contributes to the economic well being of the Company, but also converts the natural conditions from the transmission or distribution, to conditions suitable for the utilization for the natural gas. This paper reviews the functions of a meter station, the components of a meter station, and some of the problems or advantages and disadvantages involved with these components. Most meter stations provide a primary function and a number of secondary functions. The primary function is to measure the volume of gas that is passing through the station. Metering options are discussed in some detail including a comparison of the relative advantages and disadvantages of diaphragm, rotary turbine, and orifice meters. Gas arriving at the metering station usually has to be adjusted or

corrected to standard conditions. These corrections can be performed in one of two ways: either by measuring the condition and correcting or by controlling the condition. In the case of temperature generally the condition is measured and corrected for while with pressure it is split between controlling the pressure or measuring the pressure and correcting for it. It is recommended that meters should be sized correctly for the expected gas flow as both over- and undersizing can lead to errors.

27634 (PB–90-159757/XAB) **Gas Research Institute status report: Distribution and Storage (3.3) subprogram. 1984-85.** Gas Research Inst., Chicago, IL (USA). Mar 1985. 153p. (GRI–85-7002). Available from NTIS, PC A08/MF A01.

The status of activities within the GRI Distribution and Storage Subprogram are described. Tactical objectives, strategies, results, and contract status are described for these project areas: Construction and maintenance; Metering and operations management; Plastic piping materials evaluation; Residential/commercial interior piping systems; Gas storage technology; Metal piping preservation; and Pipe location.

27635 (PB–90-160060/XAB) **Review of automated custody transfer equipment for large-volume gas flow measurement. Final report, August 1, 1987-February 28, 1988.** Rush, W.F.; Tamosaitis, V. Institute of Gas Technology, Chicago, IL (USA). Jun 1989. 65p. Available from NTIS, PC A04/MF A01.

The influence of electronic automation on the accuracy of gas custody transfer measurements was investigated. The term Electronic Flow Measurement (EFM) denotes both electronic flow correctors (for positive displacement meters) and flow computers (for orifice plate measurements). Electronic devices have potential to be slightly more accurate than their mechanical counterparts. Electronic systems have the additional benefits of greater application flexibility, reduced flow corrector inventory, reduced maintenance and calibration requirements, and data storage and communication capability. The primary concerns with EFM equipment are compatibility between units made by different manufacturers and their ability to function under extreme environmental conditions.

27636 (PB–90-167628/XAB) **Transport and Storage (3.3) Subprogram for Gas Research Institute: Status report, 1985.** Gas Research Inst., Chicago, IL (USA). Mar 1986. 151p. (GRI–86-7004). Available from NTIS, PC A08/MF A01.

See also PB–89-180160.

The 1985 status report discusses activities within GRI's Transport and Storage Research Subprogram. The objectives and goals, accomplishments, strategies, and contract status are described for projects within these project areas: Construction and maintenance, Metering and distribution operations, Plastic piping materials evaluation, Residential/commercial interior piping systems, Gas storage technology, Metal piping system enhancement, and Advanced transport systems.

27637 (STEV-NGAS–89-1) **Storage of LNG in insulated rock caverns: technology and economics.** Margen, P. (MargenConsult AB, Nykoeping (SE)); Lindblom, U. Statens Energiverk, Stockholm (Sweden). 1989. 86p. Project STEV-656-076. Order Number DE90770774. Available from NTIS (US Sales Only), PC A05/MF A01.

LNG at atmospheric pressure is far denser than high pressure natural gas in the gas phase. For that reason and because of the shallower permissible location associated with the low pressure, LNG storage in rock caverns shows promise of becoming cheaper than storage of pressurized gas in the gas phase. A requirement is however that the rock temperatures are kept sufficiently high by suitable thermal insulation and a heating system, to avoid any risk of crack propagation. LNG caverns designed in this way can be used both for seasonal and strategic storage, and parts of the caverns also for short term storage. The report describes preliminary studies of a design concept, and presents performance and preliminary cost calculations for a 1 TWh cavern. The design can be based entirely on conventional components, or alternatively, introduce some further developed insulation technology to reduce investment costs. The version based on conventional components is recommended to avoid considerable time delays, and because it gives estimated overall costs comparable to those of the 'developed technology' variant when also the boil-off costs are taken into consideration. The LNG caverns are considered for two alternative scenarios. One of these involves the import of both LNG and pipe line gas to Sweden, which avoids the need of building local liquefaction plants for storage. The other scenario involves the import of pipe line gas only. The report concludes that the concept shows promise for both scenarios. Costs are considered to be lower than those for caverns for compressed natural gas storage for comparable energy storage capacity. Proposals are made for demonstrating the concept in the rock cavern demonstration facility being planned at the Chalmers University of Technology. (12 figs., 3 tabs., 15 refs.).

0330 Properties and Composition

Refer also to citation(s) 27592, 28685, 28949

27638 (CGA–CE02953, pp. 196-204) **Devices for moisture measurement in natural gas.** Mayeaux, D.P. (ESG Engineering, Tulsa, OK (USA)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

There are many problems associated with the measurement of moisture in natural gas. These problems can be placed in two general categories. First are the problem associated with measurement, calibration, and preventative procedures. The second category concerns problems associated with the design of measurement and calibration instruments. New equipment and instruction material is being developed to help overcome these problems. Extracting and transporting a representative sample to an analyzer is the key to the accurate moisture analysis of natural gas. This paper explains in detail sampling problems and techniques. Methods of calibrating analyzers are discussed The application of the Ranarex Model 741 high pressure moisture calibrator is described. This instrument can deliver gas of moisture content ranging form 9.5 to 170 pounds/MMSCF from a supply gas of pressures up to 500 pounds per square inch gauge. 7 figs.

27639 (CGA–CE02953, pp. 177-180) **Fundamentals of gas chromatography.** Cox, L. (Daniel Industries Inc., Houston, TX (USA)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

Online gas chromatography (GC) is the most accurate, reliable technique currently available for measuring the components of a gas stream. Gas chromatography is a physical method of separation where the components to be separated are distributed between two phases - a stationary bed of large surface area and a fluid that moves through the stationary bed. This paper describes the instrument, explains the basic principles of operation, installation of GC equipment, calibration of the equipment and commonly encountered problems. 6 figs.

27640 (CGA–CE02953, pp. 134-144) **Optimizing AGA-8.** Braid, C. (ITT Barton Instruments, Calgary, AB (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

A critical element for accurate flow measurement of natural gas is the compressibility factor (commonly called the Z factor) which compensates for the deviations from the ideal gas laws. There are at least twelve distinctly different ways of determining Z factors. In the gas transmission industry, the traditional method is known as NX-19[1]. This is a purely empirical algorithm which is constrained to a rather narrow temperature/pressure regime, there are restrictions

on gas composition, inaccuracies exist within its range of validity, and under some conditions it is inconsistent even with itself. In the three years since its publication, the method of computing natural gas compressibility factors described in American Gas Association (AGA) Report No. 8 has failed to gain general acceptance in the industry, despite offering superior prediction accuracy in comparison to other methods. The common perception seems to be that the algorithm is too complex and slow to be of practical use except on large computers. However it has been found that by employing efficient methods, reasonable speed can be attained on microprocessor-based computers.

27641 (CGA–CE02953, pp. 290-315) **Mathematical modelling of natural gas bypass odorizers.** Lata, E. (Titan Projects Ltd., Calgary, AB (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

Gas odorization plays an important role in the Utility Company's ability to guarantee a detectable, safe commodity. Of late, there has been much emphasis on detectability in present day odorization testing procedures. There is a lack of literature on the mechanisms of mass transfer taking place between the liquid odorant and natural gas streams. An uderstanding of these governing principles would provide the ability to engineer a bypass odorizer. This paper shows how a mathematically constructed model may be applied to the physical fabrication and implementation of bypass odorizers. The model is used to predict the amount of odorization in a bypass configured system under varying conditions of temperature, pressure and flow. Problems associated with current odorization testing procedures are discussed illuminating consideration for future test implementation. Using mathematical modeling, this paper shows typical non-linearities in operating set points between summer and winter conditions. Also, at higher temperature, control valve settings will vary the concentration more radically than at lower temperatures. At lower temperatures, however, a greater variance in concentration will occur depending on whether the bypass odorant pot is full or nearly empty. 9 figs.,3 tabs.

27642 (CGA–CE02953, pp. 387-392) **Wet gas sampling and high BTU sampling.** Welker, T.F. (Welker Engineering Co., Sugar Land, TX (USA)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

This paper reviews problems encountered in wet gas operations and discusses wet gas sampling for BTU measurement. Wet gas generally leads to the accumulation of liquids, including both water and higher hydrocarbons, in the system. These liquids create problems in lost efficiency, inaccurate measurement, hydrate formation and inaccurate chart intergration. The removal of liquids from the system is of great benifit in improved operations and measurement. Wet gas sampling presents more difficulties than conventional dry gas sampling since the liquids are frequently present as aerosols and condense out during passage throught the pipeline systems. Measurements of BTU and other properties may differ at the pipe inlet and outlet. This paper describes a procedure for wet gas sampling which gives reliable and repeatable results.

27643 (CGA–CE02953, pp. 377-386) **Composite sampling: Composite sampling to determine heating value and compositional analysis of a gas stream under investigation.** Welker, T.F. (Welker Engineering Co., Sugar Land, TX (USA)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

This paper discusses gas stream sampling systems and procedures. The object of the composite sampling system is to gather representative bites of the gas passing by the sample point and to inject the samples unchanged into a sample container for storage and transportation to an analyzing divice. A sampling system must be considered whenever on-line analysis is not used. Important facets of a composite sampling system include the location and construction of the probe, the hook-up for the sampler, the construction of the sampler and the sampler cylinder, and the system for transporting of the sample to the lab. 3 figs.

0340 Combustion

Refer also to citation(s) 27937, 28358

27644 (PB–90-168246/XAB) **Combustion system technology and application assessment: Combustion control systems. Topical report, February 1989.** Williams, S.J.; Cuervo, L.A. RCG/Hagler, Bailly, Inc., Washington, DC (USA). Feb 1989. 100p. Available from NTIS, PC A05/MF A01.

Combustion controls are a fundamental component of industrial heating systems and have a direct effect on energy consumption and energy efficiency. The compatibility of advanced gas technologies with industry's combustion control needs and preferences may be an important factor if natural gas is to retain a competitive advantage in industrial markets. In order to assess the combustion control market, information on various technologies was gathered through interviews with equipment vendors and industrial organizations. Information sought included types of controls, factors affecting technology choice and installation, and market trends. The study provides insights into the current status of combustion control systems and relates their use to various industries and process heating technologies. It assesses recent market trends, analyzes the major factors influencing technology use, and discusses the potential implications these technologies may have on natural gas combustion systems.

04 OIL SHALES AND TAR SANDS

0402 Reserves, Geology, and Exploration

Refer also to citation(s) 27533

27645 (DOE/FE–0170P) **Naval Petroleum and Oil Shale Reserves FY 1989 annual report of operations.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Petroleum Reserves. [1990]. 36p. Sponsored by U.S. DOE Fossil Energy. Order Number DE90010238. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Fiscal Year 1989 marks the end of a successful decade for the Naval Petroleum and Oil Shale Reserves. The Reserves have been used as an instrument of strategic insurance, national security, social policy and as a major source of revenues for the United States Government. The operations at the Naval Petroleum Reserves (NPRs) were also excellent examples of industrial operations carried out in harmony with the environment, and with the highest priority given to health and safety. Highlights for FY 1989 are presented. 17 figs.

0403 Drilling, Fracturing, and Mining

27646 (SAND–90-1105C) **Application of blast modeling to oil shale recovery.** Preece, D.S.; Thorne, B.J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 13p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC04-76DP00789. (CONF-9004103–1: Oil shale contractors review, Morgantown, WV (USA), 18-19 Apr 1990). Order Number DE90009835. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of this work is the development of numerical models of rock fragmentation by blasting that can be applied to oil shale recovery. Specifically, these models should be used to improve mining efficiency, evaluate alternative mining strategies and provide a basis for evaluating the blast design for in situ retort construction. 11 refs., 7 figs.

0404 Oil Production, Recovery, and Refining

Refer also to citation(s) 27652, 27654

27647 (DOE/METC–88/6098, pp. 1-7) **Oil shale program overview.** Roosmagi, C.E. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The goal of the oil shale program is to foster the development of an economically competitive and environmentally acceptable oil shale industry whose products can compete with and complement conventional petroleum liquids in the marketplace. A series of technology development steps must be taken by DOE and industry for the achievement of this goal. They include basic and applied research, process development and environmental compliance/control. The oil shale program has two major technical goals: (1) Technology Base Development-To produce an engineering and scientific information base for industry use in designing and developing oil shale processes with reduced cost and enhanced environmental acceptability; (2) Environmental Mitigation-To develop a comprehensive data base on pollutant generation and the steps required to mitigate impacts in a cost-effective manner. Both of these are briefly discusses.

27648 (DOE/METC–88/6098, pp. 13-23) **Tar sand program overview.** McLendon, T.R. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The goal of the DOE Tar Sand Program is to assist industry in commercialization efforts. Input from industry is being and will continue to be used from program guidance. The direction of the program is being focused toward specific surface extraction process problems and away from generic research. Systems analysis based evaluations will be fundamental to the selection of cooperative research and development with industry. Environmental, mining, upgrading, economics and modeling research will be directed toward support of specific processes. Fy 1988 activities of the participants of the DOE Tar Sand Program are summarized.

27649 (DOE/METC–88/6098, pp. 47-56) **Rapid pyrolysis mechanisms and product characterization.** Shadle, L.J. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The objective of the rapid pyrolysis research on oil shale at the Morgantown Energy Technology Center (METC) are to identify reaction mechanisms at various heating conditions and to provide the understanding needed to predict shale conversion and product distribution under rapid heating conditions. In response to these needs, an experimental project is in progress to develop a generic model for rapid shale retorting based on a fundamental description of the pyrolysis process. To develop such a model, one must identify the mechanisms of rapid pyrolysis, determine the rate of thermal and catalytic reaction processes, and incorporate the transport processes and properties which are important. The samples studied were shales from the Green River formation in Colorado and from the New Albany seam in Kentucky. The paper describes the flashlamp reactor, the laminar-flow entrained reactor, the wire grid reactor, curie-point pyrolysis, and product characterization. Result are discussed.

27650 (DOE/METC–88/6098, pp. 57-66) **Lawrence Livermore National Laboratory oil shale project: Improved analytical methods and measurements of rapid pyrolysis kinetics for western and eastern oil shale.** Lewis, E. (Lawrence Livermore National Lab., CA (USA)); Coburn, T.T.; Taylor, R.W.; Morris, C.J.; Duval, V. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. DOE Contract W-7405-ENG-48. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The LLNL project combines laboratory and pilot-scale experimental measurements with mathematical modeling of fundamental chemistry and physics to provide a technical base for evaluation of oil shale retorting alternatives. In this paper the authors describes recent measurements of the rate of pyrolysis of oil shales. The measurements were made by means of a laboratory fluidized bed in which the shale were flash pyrolyzed. The pyrolysis products were burned and rate of pyrolysis was calculated from the flow rate of the fluidizing gas and the concentrations of carbon dioxide and steam.

0405 Properties and Composition

Refer also to citation(s) 27578, 27649

27651 (DOE/METC–88/6098, pp. 24-34) **Oil shale reference sample bank.** Owen, L.B. (Terra Tek, Inc., Salt Lake City, UT (USA)). USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The primary objective of the Oil Shales Sample Bank (OSSB) program areto obtain bulk oil shale samples from locales in the Eastern and Western United States. Terra Tek's responsibilities include identification of potential bulk sampling sites, verification of oil yield, bulk sampling, shale processing, distribution of reference shales to DOE contractors and maintenance of the shale inventory for the duration of the program. During shale processing, ten sample splits are recovered for analysis to document bulk sample homogeneity and sample characteristics. A comprehensive report describing shale sampling, processing and results of shale characterization is provided to each reference shale sample recipient. The analytical program generates the following data set for each bulk sample: Fischer Assay (10 analyses); Mass Balance Assay (5); -60 Mesh Moisture (5); Dry Volatile Matter (5); Total Carbon (5); Mineral Carbon (5); Hydrogen (5); Nitrogen (5); Total Sulfur (5); Pyrite Sulfur (5); Sulfide Sulfur (5); and Organic Sulfur (5); The current reference shale inventory includes shales from the Exxon Colony Mine, Parachute, Colorado (average oil yield = 27.3 gpt $\pm$ 3.81%), a Tipton oil shale form an outcrop near Rock Springs, Wyoming (average oil yield = 22.8 gtp $\pm$ 3.85%), and a New Albany (Clegg Creek Member) shale from Knieriem's quarry near Louisville, Kentucky (average oil yield = 14,9 gpt $\pm$ 3.63%). Each of these deposits and the program status are described.

27652 (DOE/METC–88/6098, pp. 35-46) **Thermal decomposition of DOE reference shales.** Miknis, F.P. Dr. (Western Research Institute, Laramie, WY (USA)); Turner, T.F. USDOE Morgantown Energy Technology Center, WV (USA). Dec 1988. (CONF-880725–7: 3 annual oil shale, tar sand, and mild gasification contractors review meeting, Morgantown, WV (USA), 19-21 Jul 1988). In *Proceedings of the third annual oil shale, tar sand, and mild gasification contractors review meeting.* Order Number DE88010257. Available from NTIS, PC A21/MF A01.

The objective of this research effort is to explore the chemistry of kerogen thermal decomposition in relationship to kerogen structure. Since the kerogen in oil shales exists in a variety of structural assemblages, understanding the chemistry of kerogen pyrolysis requires investigations of the pyrolysis kinetics of several different types of kerogens. It is necessary to know the chemistry of the pyrolysis of shales having different aromatic and aliphatic carbon distributions to develop a general chemical kinetics model of kerogen decomposition. Also, by understanding these relationships it may be possible to improve the efficiency of the conversion processes or to develop novel approaches for greater conversion of

kerogen to oil. The oil shales used for this study were a New Albany oil shale (Clegg Creek Member) from Bullitt County, Kentucky, and a Mahogany Zone (Parachute Creek Member), Green River Formation shale from the Exxon Colony mine in Colorado. The pyrolysis reactor system is described. Results to date on the thermal decomposition and the nitrogen distribution in products are discussed.

27653 (EGG-M–89049) **A multipulsed dynamic diffraction moire interferometer.** Deason, V.A.; Ward, M.B. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 8p. Sponsored by U.S. Department of Defense; U.S. DOE Fossil Energy. DOE Contract AC07-76ID01570. (CONF-8908222–3: 3. international conference on laser interferometry, San Diego, CA (USA), 6-11 Aug 1989). Order Number DE90009765. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A system capable of generating several tens of diffraction moire interferograms at rates on the order of 1 MHz is described. The interferometer consists of a specially modified, segmented ruby rod laser capable of producing a long train of 40-mJ pulses each with a width on the order of 20 to 50 ns. The interferograms are recorded on film using a high speed turbine camera capable of 2,000,000 frames per second for a total record of 80 frames. The interferometer is used in conjunction with any of several devices for impulsively loading a variety of materials so as to study dynamic material deformation, fracture, delamination, or other response to dynamic stress. This apparatus is the latest in a series of dynamic diffraction moire systems built at the Idaho National Engineering Laboratory. Dynamic moire studies of Colorado oil shale are briefly discussed. 2 refs., 3 figs.

27654 **A correlation of United States tar sand bitumen viscosities with NMR spectroscopic parameters.** Netzel, D.A. (Western Research Institute, Box 3395, Laramie, WY (US)); Turner, T.F. *Fuel Science and Technology International (USA)*, 8(4): 379-404 (1990).

A method has been developed whereby the viscosity of a tar sand bitumen at any temperature can be calculated from nuclear magnetic resonance parameters. The method is semi empirical but is based upon some fundamental theoretical concepts for molecular mobility and intermolecular interactions. Using this method, the viscosities of three United States tar sand bitumens have been correlated to the weighted average spin-spin, relaxation rates for the semiliquid, solidlike mobile, and solidlike rigid phases of the bitumens. The results indicate that bitumens with a high viscosity have a greater amount of solidlike rigid phase and lesser amounts of solidlike mobile and semiliquid phases than do the bitumens with low viscosity. It is also shown that the viscosity of a tar sand bitumen over a 100 degree temperature range can be determined from a single NMR experiment conducted near room temperature.

05 NUCLEAR FUELS

0501 Reserves, Exploration, and Mining

27655 (KFK–4678) **Microwave sintering of waste loaded ceramic masses.** Donath, P. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Nukleare Entsorgungstechnik; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Wiederaufarbeitung und Abfallbehandlung. Feb 1990. 41p. (In German). (PWA–70/89). Order Number DE90773575. Available from NTIS (US Sales Only), PC A03/MF A01.

At the Institut fuer Nukleare Entsorgungstechnik (INE) experiments have been performed in recent years on sintering ceramic masses by means of microwaves. The goal has been to fix radioactive wastes in the waste forms to be sintered. While searching for a suitable shape of the furnace, we have faced questions of a fundamental nature regarding ceramic mass sintering in the microwave field. It had become apparent that the single pellet sintering of waste specimens in a radio frequency resonator yields reproducible results when metal oxides with high dielectric losses are added. The prerequisite has been that the material composition remains unchanged. Even minimum variations in the composition gave defective waste forms. The results obtained in the experiments make evident that sintering of ceramic masses still needs to be studied further in order to enable validated statements to be made about this technique. (orig.).

27656 (PNRI-B(EA)–89001) **Reconnaissance geochemical survey for uranium and related industrial minerals in Cebu Island.** Reyes, R.Y. (Philippine Atomic Research Center, Diliman, Quezon City (Philippines)); Ramos, A.F.; Magsambol, W.N.; Hernandez, E. Philippine Nuclear Research Inst., Diliman, Quezon City (Philippines). Mar 1989. 61p. Order Number DE90624461. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Consistent with the program of evaluating the nuclear mineral resource potential and related industrial minerals of the Philippines, a reconnaissance geochemical survey was conducted in Cebu with considerable success. The total area covered by the survey was about 5,088 sq. kms. The survey consisted of systematic collection of 857 geochemical stream and water and heavy mineral samples, and measurement of radioactivity in over 352 stations. The average sampling density was about one set of samples per 15 to 30 sq. kms. All solid samples were analyzed for U, Cu, Pb, Zn, Mn, Ag, Co and Ni. Uranium, radon and conductivity were measured on most water samples collected. A total of 4,518 elemental determinations were involved. All field and analytical data were treated by statistics, and the computed parameters data were correlated with the geology of the area to establish anomalous zones. Four areas were delineated for possible uranium mineralization. Of the areas, the Mandaue river area is the most interesting for uranium. The contact zone between the diorite and the sedimentary rocks in this area appears to be a favorable geological environment for uranium mineralization. The other anomalous uranium values were found to be related with the guano and phosphate deposits. Uranium was also shown to be independent of the other seven elements in the geologic environment of Cebu. No definite elemental association could be established at present. This study also marks the thorough utilization of Q'GAS, Cadplot and Autocad, all microcomputer-based programs/systems, in the evaluation and interpretation of exploration-oriented geochemical and geological data, and with more significance in the sense that computer generated quality geochemical maps were produced, a first in the country. (Author). Appendices (23); 23 figs; 13 refs.; 4 tabs.

27657 **An expert system for uranium exploration.** Chhipa, V.K. (Dept. of Mining and Geological Engineering, Univ. of Alaska Fairbanks (US)); Sengupta, M. pp. 1124 of The 21st application of computers and operations research in the mineral industry. Weiss, A. Society of Mining Engineers of AIME, Littleton, CO (USA) (1989). (CONF-8902116–: APCOM '89: 21. international symposium on application of computers and operations research in the mineral industry, Las Vegas, NV (USA), 27 Feb - 2 mar 1989).

Artificial intelligence is an emerging technology in the field of computer application. Expert systems have been developed to imitate human intelligence and reasoning process. Expert systems have much scope of application in the decision making process in mineral exploration as such decisions are highly subjective and expert opinions are very helpful. This paper presents a small expert system to analyze the reasoning process in exploring for uranium deposits in sandstone.

0504 Feed Processing

27658 (FMPC–2190) **Flexible membrane liner acceptance testing case studies.** Gimpel, R.F.; Albert, M.F. Westinghouse Materials Co. of Ohio, Cincinnati, OH (USA). Feed Materials Production Center. [1990]. 41p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-86OR21600. (CONF-9005159–1: 7. HMCRI's national RCRA/superfund conference and exhibition, St. Louis, MO (USA), 2-4 May 1990). Order Number DE90009561. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

It is natural to assume a newly installed flexible membrane liner (FML) would be leak proof. However, leak proof by definition means "zero" leakage, which is theoretically impossible. Since FMLs are not absolutely leak proof, what is an obtainable leak rate and is it acceptable? The US Environmental Protection Agency

(EPA) is considering imposition of a nationally established minimum leakage rate. In this paper, information will be given on the amount of leakage to expect from an FML and methods to maintain leakage below the EPA proposed limit. Such methods were devised and implemented during the installation of two new double-lined basins at the Feed Materials Production Center (FMPC) located near Cincinnati, Ohio. 2 refs., 7 figs.

0505 Uranium Enrichment

27659 (JAERI-M–89-185) **A study of the uranium enrichment technology of chemical method.** Fujine, Sachio (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Shiba, Koreyuki. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 38p. (In Japanese). Order Number DE90777746. Available from NTIS (US Sales Only), PC A03/MF A01.

Principal characteristics of the chemical method for uranium enrichment are studied based upon published data, and the plant features are summarized. The chemical method was found to be a promising technology, since the chemical process multiplies the unit separation effect easily and effectively despite the small separation factor. Electricity consumption rate is small compared with the conventional method. Makeup cost of uranium feed is cheap because the conversion step into UF_6 is eliminated. (author).

27660 (SIEMENS-KWU-U9–414/89/007) **Development of a 10 kHz 16 μm laser system for uranium enrichment (phase I, 1988).** Hilber, G.; Rath, W.; Jetter, H. Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). May 1989. 46p. (In German). Contract BMFT AtT 2118/B8. Order Number DE90780160. Available from NTIS (US Sales Only), PC A03/MF A01.

The objective was to establish the feasibility of an industrial-scale laser for uranium enrichment. This industrial-scale laser is to be based on multi-kW class continuous-wave CO_2 lasers using four-wave mixing to generate 16 μm radiation at a high repetition rate and average power. To this end the generation and amplification of short CO_2 laser pulses were investigated. A 150 W continuous-wave laser was used to generate Q-switched light pulses of τ=200 ns duration at a repetition rate of f=10 kHz and a pulse power of P=4.5 kW. Fast optical pulse switching shortened pulse duration to τ=28 ns. The amplification properties were characterized for a transverse-flow, high-frequency-excited CO_2 laser (average power >5 kW). It was shown that very homogeneous excitation can be established at power densities of 100 W/cm^3 and pressures up to 140 mbar. These are favourable conditions for amplifying short pulses. A set of equations was derived for the theoretical investigation of the four-wave mixing process. The pulse power of the copper vapour laser required was estimated to be P=400-450 KW. These output powers are within the range of commercial equipment. Overall, an industrial-scale laser based on the concept under investigation appears feasible with a reasonable amount of development work. (orig.) With 17 refs., 9 figs.

0507 Fuels Production and Properties

Refer also to citation(s) 27957, 28003, 28004, 28024, 28046, 28371

0508 Spent Fuels Reprocessing

Refer also to citation(s) 27783, 28057

27661 (BMU–1989-224/2+3) **Comparison of three Kr-85 separation processes of a 350 t/y fuel reprocessing plant with special reference to radiation doses. Vol. 2 and 3.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Linde AG, Hoellriegelskreuth (Germany, F.R.). Werksgruppe Tieftemperatur und Verfahrenstechnik. Dec 1988. 644p. (In German). Contract BMU St.Sch. 971. Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

Published in 2 separate volumes.

The study promoted by the German Federal Ministry for the Environment, Nature Protection and Reactor Safety (BMU) within the scope of the research work St.Sch. 971 compares three procedures for the Kr85 removal from a reprocessing plant having a capacity of 350 t per year: low temperature rectification, freon gas scrubbing, adsorption on activated carbon at low temperatures. These three procedures are compared with respect to technical criteria and from the point of view of safety and radiology; special importance is paid to the comparison of the radiological effects. For that purpose, process and engineering design of procedures and component parts has been considered, safety reflections with regard to failure analyses have been made, as well as the determination of radiation exposure concerning operating personnel and the population in the surroundings at normal operation conditions, and at failures. (orig.).

27662 (CEA-CONF–9977) **Analytical developments in reprocessing at the CEA.** Buffereau, M. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Chimie Appliquee et d'Etudes Analytiques. 1989. 8p. (CONF-890617–: 2. Karlsruhe international conference on analytical chemistry in nuclear technology, Karlsruhe (Germany, F.R.), 5-9 Jun 1989). Order Number DE90773404. Available from NTIS (US Sales Only), PC A02/MF A01.

Analytical developments in reprocessing, which are based on extensive basic research, are aimed at fulfilling current requirements of R and D laboratories, pilot plants and industrial plants. They are also intended to propose and provide new opportunities. On-line measurements are a long term goal. One must be confident of their outcome. New equipment and procedures must be tested and their specifications determined, first at the laboratory level, and then in a pilot plant. In this respect we are considering equipment which will be in operation in the ATALANTE laboratories. And APM is also both a necessary and useful resource. However, many measurements must still be done and will continue to have to be done in analytical laboratories. Along with the improvement of accuracy the main developments aim at reducing manpower requirements and effluents and waste releases.

27663 (CEA-CONF–9978) **Gas chromatography-Fourier transform infrared (GC -FTIR): application to the determination of degradation products of the solvent TBP-TPH.** Ginisty, C.; Charbonnel, M.C.; Cames, B. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Genie Radioactif. 1989. 6p. (CONF-890617–: 2. Karlsruhe international conference on analytical chemistry in nuclear technology, Karlsruhe (Germany, F.R.), 5-9 Jun 1989). Order Number DE90773405. Available from NTIS (US Sales Only), PC A02/MF A01.

This new analytical technic presents both advantages of Gas Chromatography and Fourier Transform Infrared Spectrometry. The compounds are first separated on a silica capillary column and the vapor phase analysed by IR. We first worked with synthetic solutions of nitroalkanes and alkylnitrates. Investigations on typical solvents from fuel reprocessing were then carried out. The main results are presented for two solvents: - A TBP 30% - HTP radiolysed with γ rays. This solution was provided from a simulation of the PUREX process realised through a succession of extraction-irradiation-stripping and chemical regeneration sequences. - A plant - TBP solvent on which we realised a rectification to enhance the concentration of some interesting compounds.

27664 (CEA-R–5501) **Falling film evaporators: organic solvent regeneration in nuclear fuel reprocessing.** Garcin, I. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France); Institut National Polytechnique, 54 - Nancy (France). 1989. 255p. (In French). Order Number DE90773446. Available from NTIS (US Sales Only), PC A12/MF A01.

The aim of this work was to improve knowledge about working of falling film evaporators used in nuclear fuel reprocessing plants for organic solvent regeneration. The first part deals with a non evaporation film. An original film thickness measuring technique was used; infrared thermography. It gave indications on hydrodynamics and wave amplitude and pointed out thermocapillary forces to be the cause of bad wetting of the heated wall. By another way we showed that a small slit spacing on the film distributor, an enhanced surface roughness and an important liquid flow rate favour

a better wetting. The second part deals with evaporation of a binary solvent mixture. Experiments in an industrial evaporator corroborated the fact that it is essential for the efficiency of the apparatus to work at high flow rates. We propose an over-simple model which can be used to estimate performances of co-current falling film evaporators of the process.

27665 (DNE-R–14) **The use of neptunium-239 to assess neptunium distribution throughout a nuclear fuel reprocessing plant.** Mair, M.A.; Savage, D.J.; Prentice, P.C. UKAEA Dounreay Nuclear Power Development Establishment (UK). Aug 1989. 13p. (CONF-890617–: 2. Karlsruhe international conference on analytical chemistry in nuclear technology, Karlsruhe (Germany, F.R.), 5-9 Jun 1989). Order Number DE90624306. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A radiometric technique has been devised to use the gamma emission from the neptunium-239 daughter of americium-243 to estimate neptunium distribution in a plant reprocessing irradiated plutonium based fuels. Three trials were undertaken with samples from the Prototype Fast Reactor at Dounreay. The trials have confirmed the previous chemical measurements and the usefulness of this technique to highlight the effect of altered flowsheet conditions. (author).

27666 (DNE-R–15) **A voltammetric system for in-line heavy metal measurements in nuclear fuel reprocessing plants - development and operational experience.** Skea, D.C.J.; Mackay, E. UKAEA Dounreay Nuclear Power Development Establishment (UK). Aug 1989. 19p. (CONF-890617–: 2. Karlsruhe international conference on analytical chemistry in nuclear technology, Karlsruhe (Germany, F.R.), 5-9 Jun 1989; SRDP–R158). Order Number DE90624307. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A voltammetric in-line measurement system for uranium and plutonium in aqueous steams has been developed. It comprises a desk-top computer, potentiostat and remote sensor. A sensor consists of noble metal electrodes (working, counter, quasi-reference) assembled in a single probe, which can be operated over large distances. The potentiostat is capable of performing modern pulse voltammetry techniques, and has a floating (not earthed) working electrode facility which allows measurement of earthed (stainless steel plant) streams. The operating software is completely accessible to the user. The flexibility of the software allows continuous conditioning of the sensing electrode, and hence good measurement reproducibility over long periods. Aspects of underlying studies into the effects of common plant variables (physical and chemical) on remote voltammetric measurements are discussed. The measurement system and installations in development rigs and in the Fast Reactor Fuel Reprocessing Plant, Dounreay Nuclear Power Development Establishment, are described. Operational experience of these installed measurement systems is discussed. (author).

27667 (JAERI-M–89-188) **Basic analysis of pyrometallurgical reprocessing of transuranium fuels.** Ogawa, Toru (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 21p. (In Japanese). Order Number DE90777747. Available from NTIS (US Sales Only), PC A03/MF A01.

Feasibility of transmutation of transuranium elements (TRU) largely depends on the efficiency and safety of TRU fuel cycle. Considering the nature of TRU fuels, pyrometallurgical processing is a major alternative to be investigated. In order to supply a basis for analyzing the separation of rare earths from actinides, chemical partitioning in the system of liquid Cd and an alkaline fused salt (LiCl-KCl eutectic melt) was estimated. Equations to describe the separation in fused salt electrolysis are also given. Separation of rare earths from Am was analyzed as an example. (author).

27668 (KFK–4667) **Purex process related distribution data on neptunium(IV,VI).** Kolarik, Z.; Dressler, P. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Heisse Chemie; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Wiederaufarbeitung und Abfallbehandlung. Jan 1990. 25p. Order Number DE90773724. Available from NTIS (US Sales Only), PC A03/MF A01.

Own and published data on the extraction of Np(IV) and Np(VI) with tributyl phosphate (TBP) are gathered in the report. Purex process related data are solely considered. The scope of the gathering is limited to systems involving a 30 vol.% solution of TBP in an aliphatic diluent, and an aqueous nitrate solution. The concentration ranges in the equilibrium aqueous phase are 0.1-11 M HNO_3, 0-210 g U(VI)/l und $<$0.03 g Np(IV,VI)/l. The temperature range is 25-60deg C. The distribution ratios of Np(IV) and Np(VI) were critically assessed and obviously erroneous values were indicated. (orig.).

27669 (SIEMENS-KWU-U9–414/89/011) **Electrocoagulation of fission product colloids in dissolver solutions from reprocessing of nuclear fuel with high burnup.** Bereznai, T.; Wuertz, R. Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Jul 1989. 106p. (In German). Contract BMFT KWA 1604/1. Order Number DE90780162. Available from NTIS (US Sales Only), PC A06/MF A01.

An electrochemical process for separating undissolved or colloidally dissolved fine particles out of the fuel solution resulting from the reprocessing of nuclear fuel was tested under virtually realistic conditions in the hot cells. Ruthenium 106, the isotope used as the tracer nuclide for the undissolved fission product phases, was separated with a yield of up to 50% from a nitric acid solution of a spent nuclear fuel (burnup approx. 52 GWd/t-U) using a fixed-bed cathode made up of zircaloy chips and a platinized titanium anode. Micro filtration (1 μm membrane filter and diatomaceous earth filtration) performed using the same solution reduced the ^{106}Ru by 20% only. SEM and gamma spectroscopic investigations of the particles deposited on the fixed-bed cathode indicate the morphological and chemical similarity with the ε phase known from the analyses of fuel dissolution residues. (orig.) With 10 refs., 9 tabs., 56 figs.

27670 (WSRC-RP–89-812) **Modeling of combustion processes in a solid fuel particle.** Howard, D.W. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 24p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-9003132–1: IBM 3090 supercomputing competition meeting, White Plains, NY (USA), 1 Mar 1990). Order Number DE90009140. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

During the production of granules of uranium oxide, granules of ion exchange resin, loaded with uranium ions, are burned to remove the resin matrix and leave a uranium oxide "ash". Under some conditions of combustion, the oxide granules are produced in a highly fractured, porous state, while other conditions result in hard, dense, solid granules. ABAQUS, a commercial finite-element code, run on an IBM 3090, was used to model the physical processes occurring during combustion: heat transfer with a very nonlinear temperature-dependent rate of heat generation, diffusion of reactants and products, and stress/strain resulting from the differential temperatures and from the phase changes during the combustion. The ABAQUS simulation successfully explained the differences in morphology of the granules under different conditions, and lead to control strategies to produce the desired morphology. 10 figs.

0509 Transport, Handling, and Storage

Refer also to citation(s) 27673, 27675, 27705, 27706, 27707, 27708, 28020

27671 (EGG-NERD–7444-Rev.2) **Criticality safety evaluation for pathfinder fuel elements in model No. RA-3 shipping containers: Revision 2.** Jones, R.R. EG and G Idaho, Inc., Idaho Falls, ID (USA). Feb 1990. 34p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009618. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Pennsylvania State University presently possesses approximately 415 Pathfinder fuel elements which require shipment from their nuclear facility. It is planned to use Model No. RA-3 shipping

containers for shipment of these elements. Certificate of Compliance No. 4986, Revision No. 22, Docket No. 71-4986 authorizes the use of these containers for Fissile Class 1 shipments of UO_2 fuel assemblies and UO_2 fuel rods with parameters similar to the Pathfinder fuel elements. Criticality safety calculations have been performed with the Monte Carlo code, KENO-V.a and 16-group Hansen-Roach cross sections for shipment of Pathfinder fuel elements in Model No. RA-3 shipping containers. The analysis is described and the results are given in this report. This analysis demonstrates that the RA-3 container with Pathfinder fuel elements complies with the requirements of 10 CFR 71.59 for Fissile Class 2 shipping containers with six as the allowable number of containers in a single shipment. 5 refs., 5 tabs., 6 figs.

27672 Calculation of health risks from spent-nuclear-fuel transportation accidents. Chen, S.Y. (Argonne National Lab., IL (USA)); Yuan, Y.C. pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104--: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

Models developed to analyze potential radiological health risks from various accident scenarios during transportation of spent nuclear fuels are described. The models are designed both for detailed route-specific risk analyses and for use in conducting overall risk analyses for route selection and related decision-making activities. The radiological risks calculated include individual dose commitments, collective dose commitments, and long-term (100-year) environmental dose commitments to a population following release of radioactivity. To facilitate route-specific analysis, a state-levle database was developed and incorporated into the model. Route-specific analysis is demonstrated by the calculation of radiological risks resulting from various accident scenarios, as postulated by the recent US Nuclear Regulatory Commission Modal Study, for four representative states selected from various regions of the US.

0510 Economic, Industrial, and Business Aspects

Refer also to citation(s) 27676

27673 (SAND--89-0018, pp. 179-188) **Feasibility of performing criticality experiments with spent LWR fuel.** Bierman, S.R. (Pacific Northwest Lab., Richland, WA (USA)). Sandia National Labs., Albuquerque, NM (USA). Oct 1989. (TTC--0884;CONF-880251--: U.S. Department of Energy workshop on the use of burnup credit in spent fuel transport casks, Washington, DC (USA), 21-22 Feb 1988). In *Proceedings of a workshop on the use of burnup credit in spent fuel transport casks.* Order Number DE90004976. Available from NTIS, PC A15/MF A01.

Considering fuel operating histories, i.e., burnup, in criticality analyses and control involves two distinctly different issues. One of these issues is concerned with the design and fabrication of fuel shipping and storage systems. The other issue is concerned with the verification of actual operating practices in the field. Both design and verification activities would benefit from physical measurement data as opposed to relying on administrative controls and calculations; however, it is the authors intention to address only the feasibility of obtaining experimental spent fuel criticality data in support of the design effort. The author discusses the background, obstacles, feasibility conclusions reached when applying burnup concepts to spent fuels.

0520 Waste Management

Refer also to citation(s) 27670, 27759, 27767, 27769, 28043, 28057, 28131, 28149, 28405, 28486, 28545, 28547, 29047, 29052, 29071, 29270, 29275, 29850

27674 (AEEW-R--2517) **Radionuclide getters in the near-field chemistry of repositories. Annual report - February 1989.** Holland, T.R.; Lee, D.J. UKAEA Atomic Energy Establishment, Winfrith (UK). Materials Technology Div. Feb 1989. 46p. Order Number DE90625199. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A programme of work has commenced to assess the radionuclide sorption efficiency of selected inorganic 'getters' incorporated into sulphate resisting Portland cement; as a means of enhancing the retention of radioactive species by the proposed repository backfill. For this initial study, a limited number of radioisotopes have been selected, with particular reference to those likely to be mobile in an alkaline environment, ie. Ra-266, Cs-134 and I-125. The getters chosen for this stage of the programme were Clinoptilolite, Molecular Sieve 5a, Tobermorite and Ferric Floc. (author).

27675 (CONF-900608--11) **Trajectory generation for car-like robots.** Vasseur, H.A.; Pin, F.G. Oak Ridge National Lab., TN (USA). [1990]. 13p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From American Nuclear Society annual meeting; Nashville, TN (USA); 10-15 Jun 1990. Order Number DE90008407. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Autonomous robots or remotely operated vehicles have raised high hopes in the military and industrial communities because of the potential safety improvement and gain of productivity they may provide. Waste management on nuclear sites, pallet manipulation in factories, interventions on battle-fields, etc., are actively studied. A lot of these applications require powerful four-wheel vehicles, the kinematics of which is similar to that of a car. Such vehicles have three degrees of freedom: the (x,y) positions in a plane and the orientation of the vehicle. Path planning is often understood as only changing the position of the vehicle, whereas the tasks performed by this kind of robot requires a perfect orientation of the vehicle: forklifting a pallet or docking at a loading or unloading station requires accuracy in the orientation of the vehicle. It is this requirement and the kinematic constraints of the motion mode which have led to the path-planning algorithm presented in this paper. The velocity of the robot belongs to a two-dimensional vectorial space. However, we assume that there is no slipping of the wheels. Therefore, at a given position, the direction of the velocity of the rear axle, is colinear with that of the vehicle. The equation conveying this constraint is not integrable and affects the velocity but not the space of the configurations of the robot: it is a non-holonomic constraint. If the steering angle of the front wheels is constant, the vehicle moves along a circle. Since the steering angle of the car-like robots is limited, the radius of the circle is always greater than a certain value which is the minimum radius of curvature of any achievable trajectory. 3 refs., 8 figs.

27676 (CONF-900690--1) **Challenges in estimating waste confinement costs.** Rivera, A.L. Oak Ridge National Lab., TN (USA). 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 34. annual meeting of the American Association of Cost Engineers; Boston, MA (USA); 24-27 Jun 1990. Order Number DE90005265. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper presents a systems analysis framework for cost estimating and outlines the challenges likely to be confronted during the cost estimating and data base development process. 1 ref., 8 figs.

27677 (DOE/ID--12116) **Assessment of CREAMS [Chemicals, Runoff, and Erosion from Agricultural Management Systems] and ERHYM-II [Ekalaka Rangeland Hydrology and Yield Model] computer models for simulating soil water movement on the Idaho National Engineering Laboratory.** Laundre, J.W. (Idaho State Univ., Pocatello, ID (USA). Dept. of Biological Sciences). USDOE Radiological and Environmental Sciences Lab., Idaho Falls, ID (USA). May 1990. 46p. Sponsored by U.S. DOE Radioactive Waste Management. Order Number DE90010233. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

The major goal of radioactive waste management is long-term containment of radioactive waste. Long-term containment is dependent on understanding water movement on, into, and through trench caps. Several computer simulation models are available for predicting water movement. Of the several computer models available, CREAMS (Chemicals, Runoff, and Erosion from Agricultural Management Systems) and ERHYM-II (Ekalaka Rangeland Hydrology and Yield Model) were tested for use on the Idaho National Engineering Laboratory (INEL). The models were calibrated, tested for sensitivity, and used to evaluate some basic trench cap

designs. Each model was used to postdict soil moisture, evapotranspiration, and runoff of two watersheds for which such data were already available. Sensitivity of the models was tested by adjusting various input parameters from high to low values and then comparing model outputs to those generated from average values. Ten input parameters of the CREAMS model were tested for sensitivity. 17 refs., 23 figs., 20 tabs.

27678 (DOE/RL–88-31-Draft-D) **Remedial investigation/feasibility study work plan for the 300-FF-1 operable unit, Hanford Site, Richland, Washington.** Department of Energy, Richland, WA (USA). Richland Operations Office. Mar 1990. 429p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90009774. Available from NTIS, PC A19/MF A01; OSTI; INIS.

Over 1,400 waste facilities have been identified on the Hanford Site. Most of the waste facilities are located within geographic areas on the Hanford Site that are referred to as the 100, 200, 300, 400, and 1100 areas. The purpose of this work plan is to document the project scoping process and to outline all remedial investigation/feasibility study (RI/FS) activities, to determine the nature and extent of the threat presented by releases of hazardous substances from the operable unit, and to evaluate proposed remedies for such releases. The goal of the 300-FF-1 remedial investigation (RI) is to provide sufficient information needed to conduct the feasibility study (FS), by determining the nature and extent of the threat to public health and the environment posed by releases of hazardous substances from 300-FF-1, and the performance of specific remedial technologies. 62 refs., 28 figs., 48 tabs.

27679 (DOE/RL–88-32-Rev.1) **Remedial investigation/feasibility study work plan for the 200-BP-1 operable unit, Hanford Site, Richland, Washington: Revision 1.** USDOE Richland Operations Office, WA (USA). Mar 1990. 666p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. Order Number DE90009857. Available from NTIS, PC A99/MF A01; OSTI; INIS; GPO Dep.

The document is the work plan for the remedial investigation of the Hanford Site. The purpose of the work plan is to guide DOE and Westinghouse Hanford Company in the implementation of all remedial investigation/feasibility study (RI/FS) activities conducted at this operable unit. The ultimate goal of the activities at the Hanford Site is to select and implement a cost effective, remedial alternative that mitigates threats to, and provides protection of, public health, welfare, and the environment, consistent with regulatory requirements and guidelines established by Environmental Protection Agency (EPA) and Ecology. Primary objectives of the RI are to collect data on site and waste characteristics, contaminant pathways, and transport mechanisms, and to conduct treatability testing as necessary to support the evaluation of proposed remedies. 76 refs., 37 figs., 35 tabs.

27680 (EGG-M–89029) **Flow and transport of radionuclides in unsaturated fractured basalt.** Walton, J.C.; Baca, R.G.; Rasmussen, T.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 8p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC07-76ID01570. (CONF-890207–38: Waste management '89: 15th international waste management symposium conference, Tucson, AZ (USA), 26 Feb - 2 mar 1989). Order Number DE90009619. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A modeling analysis of radionuclide transport in the vadose zone is described. The central focus of the modeling is to develop an understanding of the nature of flow and transport at the site of concern. Characterization of the site is still incomplete, including the presence of perched water, and observed contaminant migration. The problem of modeling fluid flow and transport processes is made difficult by the alternate layers of sedimentary materials and fractured basalts that characterize the geologic setting. The modeling results give qualitative agreement with monitoring data from the site — suggesting that fracture flow is an important component of the flow system. 7 refs., 9 figs.

27681 (EGG-M–89195) **Status of activities: Low-level radioactive waste management in the United States.** Ozaki, C.B.; Shilkett, R.C.; Kirkpatrick, T.D. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-891006–16: Joint international waste management conference, Kyoto (Japan), 23-28 Oct 1989). Order Number DE90009647. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A primary objective of low-level radioactive waste management in the United States is to protect the health and safety of the public and the quality of the environment. In support of this objective is the development of waste treatment and disposal technologies designed to provide stabilization and long-term institutional control of low-level radioactive wastes. Presented herein is a technical review of specific low-level radioactive waste management activities in the United States. Waste treatment and disposal technologies are discussed along with the performance objectives of the technologies aimed at protecting the health and safety of the public and the quality of the environment. 13 refs., 4 figs.

27682 (EGG-M–89352) **Issues in radioactive mixed waste compliance with RCRA [Resource Conservation and Recovery Act]: Some examples from ongoing operations at the Idaho National Engineering Laboratory.** Eaton, D.L. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Smith, T.H.; Clements, T.L. Jr.; Hodge, V. EG and G Idaho, Inc., Idaho Falls, ID (USA). 27 Feb 1990. 10p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-890207–37: Waste management '89: 15th international waste management symposium conference, Tucson, AZ (USA), 26 Feb - 2 mar 1989). Order Number DE90009612. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Radioactive mixed waste is subject to regulation under both the Resource Conservation and Recovery Act (RCRA) and the Atomic Energy Act (AEA). The regulation of such waste is the responsibility of the Environmental Protection Agency (EPA) and either the Nuclear Regulatory Commission (NRC) or the Department of Energy (DOE), depending on whether the waste is commercially generated or defense-related. The recent application of the RCRA regulations to ongoing operations at the DOE's Idaho National Engineering Laboratory (INEL) are described in greater detail. 8 refs., 2 figs.

27683 (EGG-M–89371) **Evaluation of technologies for remediation of disposed radioactive and hazardous wastes in a facility at the Idaho National Engineering Laboratory.** Reno, H.W.; Martin, D.D.; Rasmussen, T.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 10p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-890207–39: Waste management '89: 15th international waste management symposium conference, Tucson, AZ (USA), 26 Feb - 2 mar 1989). Order Number DE90009634. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

For the past twenty years the US Department of Energy has been investigating and evaluating technologies for the long term management of disposed transuranic contaminated wastes at the Radioactive Waste Management Complex of the Idaho National Engineering Laboratory. More than fifty technologies have been investigated and evaluated and three technologies have been selected for feasibility study demonstration at the complex. This paper discusses the evaluation of those technologies and describes the three technologies selected for demonstration. The paper further suggests that future actions under the Comprehensive Environmental Response, Compensation, and Liability Act should build from previous evaluations completed heretofore. 18 refs., 3 figs., 1 tab.

27684 (EGG-M–89477) **Instrumentation and computational techniques and resulting geostatistical characterization of INEL vadose zone basalt.** Knutson, C.F.; McCormick, K.A. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 17p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-9004169–1: 26. engineering geology symposium, Pocatello, ID (USA), 4-6 Apr 1990). Order Number DE90009768. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The geostatistical characterization of the Eastern Snake River Plains (ESRP) basalt found in the vadose zone at Idaho National Engineering Laboratory (INEL) depend heavily upon instrumentation and computer programs developed by the INEL Geoscience Unit personnel. Laboratory measurements of permeability, porosity, density, capillary pressure-pore-size distributions, and surface area were carried out with equipment developed and fabricated at INEL, and computation of the characterization parameters was carried

out using personal computers, with computer programs specifically written for this purpose by the authors. Geostatistical analysis results from Hell's Half Acre were also used to develop distribution models for medial/distal length:width:thickness substrate elements. 3 refs., 10 figs.

27685 (EGG-M–89491) **Monitoring and sampling perched ground water in a basaltic terrain.** Hubbell, J.M. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 15p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-9005149–3: 4. national outdoor action conference, Las Vegas, NV (USA), 14-17 May 1990). Order Number DE90009644. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Perched ground water zones can provide significant information on water and contaminant movement. This paper presents information about perched ground water obtained from drilling and monitoring at a hazardous and radioactive waste disposal site at the Idaho National Engineering Laboratory. Six of forty-five wells drilled at the Radioactive Waste Management Complex have detected perched water in basalts above sedimentary interbeds. This paper describes the distribution and characteristics of perched ground water. It discusses perched water below the surficial sediments in wells at the RWMC, the characteristics of chemical constituents found in perched water, the implications for contaminant transport in the unsaturated zone of water, and the lateral extent of perched water. Recommendations are made to increase the probability of detecting and sampling low yield perched water zones. 6 refs., 6 figs., 2 tabs.

27686 (EGG-M–90030) **Regulatory controls on the hydrogeological characterization of a mixed waste disposal site, Radioactive Waste Management Complex, Idaho National Engineering Laboratory.** Ruebelmann, K.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-9004169–2: 26. engineering geology symposium, Pocatello, ID (USA), 4-6 Apr 1990). Order Number DE90009766. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Following the detection of chlorinated volatile organic compounds in the groundwater beneath the SDA in the summer of 1987, hydrogeological characterization of the Radioactive Waste Management Complex (RWMC), Idaho National Engineering Laboratory (INEL) was required by the Resource Conservation and Recovery Act (RCRA). The waste site, the Subsurface Disposal Area (SDA), is the subject of a RCRA Corrective Action Program. Regulatory requirements for the Corrective Action Program dictate a phased approach to evaluation of the SDA. In the first phase of the program, the SDA is the subject of a RCRA Facility Investigation (RIF), which will obtain information to fully characterize the physical properties of the site, determine the nature and extent of contamination, and identify pathways for migration of contaminants. If the need for corrective measures is identified during the RIF, a Corrective Measures Study (CMS) will be performed as second phase. Information generated during the RIF will be used to aid in the selection and implementation of appropriate corrective measures to correct the release. Following the CMS, the final phase is the implementation of the selected corrective measures. 4 refs., 1 fig.

27687 (EGG-M–90045) **Managing previously disposed waste to today's standards: The Idaho buried waste program.** EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 13p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-900210–42: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90009615. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A Radioactive Waste Management Complex (RWMC) was established at the Idaho National Engineering Laboratory (INEL) in 1952 for controlled disposal of radioactive waste generated at the INEL. Between 1954 and 1970 waste characterized by long lived, alpha emitting radionuclides from the Rocky Flats Plant was also buried at this site. Migration of radionuclides and other hazardous substances from the buried Migration of radionuclides and other hazardous substances from the buried waste has recently been detected. A Buried Waste Program (BWP) was established to manage cleanup of the buried waste. This program has four objectives: (1) determine contaminant sources, (2) determine extent of contamination, (3) mitigate migration, and (4) recommend an alternative for long term management of the waste. Activities designed to meet these objectives have been under way since the inception of the program. The regulatory environment governing these activities is evolving. Pursuant to permitting activities under the Resource Conservation and Recovery Act (RCRA), the Department of Energy (DOE) and the Environmental Protection Agency (EPA) entered into a Consent Order Compliance Agreement (COCA) for cleanup of past practice disposal units at the INEL. Subsequent to identification of the RWMC as a release site, cleanup activities proceeded under dual regulatory coverage of RCRA and the Atomic Energy Act. DOE, EPA, and the State of Idaho are negotiating a RCRA/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Interagency Agreement (IAG) for management of waste disposal sites at the INEL as a result of the November 1989 listing of the INEL on the National Priority List (NPL). Decision making for selection of cleanup technology will be conducted under the CERCLA process supplemented as required to meet the requirements of the National Environmental Policy Act (NEPA). 7 figs.

27688 (EGG-PRA–4032) **Hazards assessment of the hazardous waste storage facility.** Trusty, A.D.; Haney, L.N.; Satterwhite, D.G. EG and G Idaho, Inc., Idaho Falls, ID (USA). Mar 1989. 70p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009807. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report documents a failure/hazards analysis of the Hazardous Waste Storage Facility and its operation. The analysis was performed to identify possible facility vulnerabilities that could lead to the release of hazardous waste material at the facility and estimate their probability of occurrence during each year of operation. The analysis addresses release scenarios that could occur within the facility and those to the external environment during the shipping and receiving operations. Fault tree analysis in conjunction with human reliability analysis techniques were used to model facility ranking of the possible facility and operational release vulnerabilities and thus provides facility management with a decisional tool to evaluate risk exposure and implement changes as deemed necessary to reduce the facility risk profile. The analysis does not provide actual risk exposure associated with facility operations since release consequences were beyond the scope of the analysis. The primary area is related to waste generator operations. The second major area of vulnerability is related to forklift operations at the facility.

27689 (EGG-WM–8727-Rev.1) **Subsurface Disposal Area (SDA) waste identification (1952–1970 emphasis): Revision 1.** Vigil, M.J. EG and G Idaho, Inc., Idaho Falls, ID (USA). Oct 1989. 49p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC07-76ID01570. Order Number DE90009762. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This report summarizes available information concerning the general identification of hazardous and radioactive contaminated waste material disposed in the Subsurface Disposal Area (SDA) of the Radioactive Waste Management Complex (RWMC) at the Idaho National Engineering Laboratory (INEL). Particular emphasis will be given to the 1952 to 1970 time period since it was during this time that transuranic (TRU) radionuclide contaminated waste was disposed below ground with low-level waste (LLW). This report covers off-site and site-generated waste. Most of the waste disposal information collected to date represents estimates of the amount of waste material disposed of at the SDA. Several task projects were completed in FY-1989. Continuing research in FY-1990 will gain more specific information on the waste disposed of in the SDA. The scope of this report is on the waste generated and buried in the SDA during 1952 through 1970. The waste disposal investigation to date has included: researching records and logbooks; reviewing past photographs and technical drawings; interviewing/debriefing personnel familiar with past waste management practices at the INEL; and analyzing existing data bases. This report is a compilation of information gathered from the FY-1989 efforts as well an extensive amount of information gained from research conducted in the 1970s and early 1980s. 18 refs., 11 figs., 11 tabs.

27690 (FRNC-TH-3536) **Respective influence of thermodynamic, hydrodynamic and diffusion factors on ion exchanger operation. Application to the ion exchanger NYMPHEA.** Nicoud, R.M. Institut National Polytechnique, 54 - Nancy (France). 1987. 343p. (In French). Order Number DE90773324. Available from NTIS (US Sales Only), PC A15/MF A01.

Nymphea is an annular ion exchanger, with a resin bed 30 centimeter-thick, used for purification of the water from the spent fuel storage pool at La Hague reprocessing plant. Very low concentration solutions (10^{-12} eq/l for cobalt) are purified by Nymphea, and parameter must be extrapolated from the range 0.01 - 0.0001 eq/l to very low concentrations. A model is developed, describing ion state inside the grains. The limiting step in Nymphea operation is external diffusion. Diffusion time is determined by mean grain size which should be accurately defined for extrapolation of results from monodispersed distribution (often the case in laboratories) to polydispersed (often the case in industry). Operation of an ion exchanger can be simulated for any ion number in solution. In steady state condition of concentration pool purification increases with flow rate. Simulation in transient operation allows the determination of all the concentrations in function of time and hence to calculate the time to reach the maximum permissible concentration for cobalt. This time depends upon calcium pollution (by fuel can dissolution, atmospheric pollution) which is not accurately known.

27691 (JAERI-M-89-200) **Waterproof effect of plastic coating on radioactive waste solids.** Ito, Akihiko (Japan Leather Research Lab., Tokyo (Japan)); Yana, Hisashi; Niizuma, Fumiaki; Sato, Mamoru; Matsuzuru, Hideo. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 30p. (In Japanese). Order Number DE90777750. Available from NTIS (US Sales Only), PC A03/MF A01.

Leaching of Radionuclides from the radioactive waste solids occurs through the water media penetrated into the waste solids. Water permeability of plastic films and rate of water penetration into the waste solids without plastic coating have been determined, then the water proof effect of the plastic coating in the waste solids is evaluated. It is concluded that an appreciable water proof effect could be expected by means of plastic coating on the radioactive waste solids. (author).

27692 (JAERI-M-89-211) **Studies on diffusion of ^{137}Cs in cement mortar.** Takebe, Shinichi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Shimooka, Kenji; Wadachi, Yoshiki; Kuramoto, Yuzuru. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 18p. (In Japanese). Order Number DE90777744. Available from NTIS (US Sales Only), PC A03/MF A01.

Penetration experiment of ^{137}Cs into the impermeable cement mortar which has been treated by the impermeable reagent (XYPEX reagent) was carried out in order to advance the performance of engineered barrier for Low Level Radioactive Waste. The result showed that the radioactive concentration at deeper region in the impermeable cement mortar specimen was decreased about 1 order of magnitude below that in the untreated specimen. Diffusion coefficient calculated from the radioactive concentration of ^{137}Cs in the cement mortar specimen was 9.1×10^{-5} cm^2/day for untreated cement mortar specimen and 4.0×10^{-5} cm^2/day for the impermeable cement mortar specimen, respectively. Treatment of cement mortar by the impermeable reagent was found to be effective to reduce the value of appearent diffusion coefficient for ^{137}Cs in the cement mortar. (author).

27693 (KAERI/RR-720/88/ST1) **A study on the structural behaviour of rock caverns for underground radioactive waste repository(II): Structural behaviour of an underground rock cavern under earthquake loadings.** Kim, Jhin Wung (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Seo, Jeong Moon; Kim, Sun Hoon; Hwang, Shin Il; Kim, Dae Hong; Lee, Kyung Jin; Choi, Kyu Sup. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 209p. (In Korean). Order Number DE90624467. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The objective of this study is to develope the basic technology necessary for the assurance of structural safety of rock caverns for a permanent radioactive waste repository. The structural analysis of rock caverns subjected to external loads, especially seismic loads, is performed to make sure of the structural integrity of the underground radioactive repository, and finally seeking the sufficient isolation of radioactive wastes from the human life environment during the hazardous lifetime of radionuclides. It is generally known that the structural behavior of rock caverns is greatly influenced by the type of structures and material properties of rock masses around the cavern. In order to develop seismic analysis techniques of underground structures such as the radioactive waste repository, the followings should be studied: depth and site dependence of earthquake characteristics, dynamic material properties of rock, modelling the behavior of rock discontinuities, and structural analysis methods. This study reviews the present status of the research on the aforementioned areas and includes the dynamic structural analysis of the underground cavern subjected to earthquake loading in order to assess the structural stability of an underground radioactive waste repository. (Author).

27694 (KFK-4642) **On the chemical behaviour of technetium during treatment of high-level radioactive waste.** Vida, J. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Heisse Chemie; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Chemie. Dec 1989. 121p. (In German). Order Number DE90773546. Available from NTIS (US Sales Only), PC A06/MF A01.

This work deals with 1. the behaviour of technetium during the vitrification of high-level radioactive waste, 2. the dissolution behaviour of technetium dioxide which is an important compound with regard to the geological disposal of high-level radioactive waste, 3. the leaching behaviour of glasses containing technetium. Incorporation and volatilization of technetium in the course of melting glass frits containing technetium was studied on a laboratory scale. The chemical state of the incorporated technetium was studied by means of X-ray microanalysis and EPR spectroscopy. The investigation of the dissolution behaviour of technetium dioxide in different aqueous systems (HCl, HNO_3, NaOH, Na_2CO_3) has shown that under aerobic conditions TcO_2 dissolves without a solubility equilibrium being established. Only heptavalent technetium in the form of pertechnetate was detected in the solutions. Under aerobic conditions, the dissolution rate of TcO_2 is controlled by the oxidation potential of tetravalent to heptavalent technetium at the surface of the oxide. The dissolution rate depends on the surface properties and thus on the thermal pretreatment of the utilized oxide. Static leach experiments were performed on glasses containing technetium. In case of a borosilicate glass which contained heptavalent technetium, technetium was released by a diffusion controlled mechanism. Leaching a glass ceramic containing metallic technetium and technetium in oxidation states lower than 7+, a retention of technetium was observed after some time which was probably caused by a gel layer growing on the surface of the specimen. (orig./MM).

27695 (LA-UR-90-638) **Exploratory shaft facility: It's role in the characterization of the Yucca Mountain site for a potential nuclear repository.** Kalia, H.N.; Merson, T.J. Los Alamos National Lab., NM (USA). 1990. 23p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-36. (CONF-9006120-1: International symposium on unique underground structures, Denver, CO (USA), 12-15 Jun 1990). Order Number DE90007495. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The US Department of Energy is characterizing Yucca Mountain, Nevada, to assess its suitability as a potential site for the permanent disposal of high-level radioactive waste from nuclear power plants and defense related activities. The assessment activities include surface investigations, drill holes from the surface, and an underground facility for in situ characterization tests. This underground exploratory shaft facility is being designed to meet the criteria for characterizing the mountain as described in the Site Characterization Plan. 9 refs., 9 figs., 1 tab.

27696 (LA-UR-90-720) **Daytime wind valleys adjacent to the Great Salt Lake.** Stone, G.L. (Los Alamos National Lab., NM (USA)); Hoard, D.E. Los Alamos National Lab., NM (USA). [1990]. 22p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9006111-2: 5.

conference on mountain meteorology, Boulder, CO (USA), 26-29 Jun 1990). Order Number DE90008991. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In 1986 Los Alamos National Laboratory was engaged by the US Army to study the meteorological aspects of emergency preparedness at several sites where toxic materials are stored and handled. The project included a series of tracer and meteorological field experiments in the vicinity of the Tooele Army Depot. These experiments generated a large data set for validating numerical simulations and for empirical analyses of the local meteorology. This paper discusses the main characteristics of the daytime, up-valley flow at the Utah site, including frequency of occurrence, horizontal and vertical structure, and temporal evolution. Some parameters controlling the variability in onset time for up-valley flow are identified, and an empirical forecasting scheme is discussed. 16 refs., 7 figs.

27697 (LBL–28444) **In-situ fracture stiffness determination.** Hesler, G.J. III (California Univ., Berkeley, CA (USA). Dept. of Materials Science and Mineral Engineering); Zheng, Z.; Myer, L.R. Lawrence Berkeley Lab., CA (USA). Jan 1990. 7p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC03-76SF00098. (CONF-900640–4: International conference on rock joints, Loen (Norway), 4-6 Jun 1990). Order Number DE90009202. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In-situ experiments to determine the hydrologic and mechanical characteristics of large naturally occurring fractures have been conducted at the NAGRA test site in Grimsel, Switzerland. In addition to seismic measurements across a fracture resulting from pressurization of the zone was also measured. The deformation is modeled in three different ways: as a mathematical crack employing linear elastic fracture mechanics; as a mathematical crack with an additional restraining stiffness between the faces of the crack, and as a row of coplanar two-dimensional cracks. 6 refs., 6 figs.

27698 (NAGRA-NTB–84-20) **Geoscientific bases of the exploratory site Oberbauen Stock: Volume 1.** Schneider, T.R. (Uerikon (Switzerland)); Kappeler, S.W. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Dec 1984. 150p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

The geological and hydrogeological conditions prevailing in the region of the investigation site Oberbauen Stock have been chosen as model data-set, in the frame of project Gewaehr 1985, for a type B (low and intermediate level) waste repository. The report, in its capacity as a reference report for project Gewaehr presents all available, relevant site data applicable to modeling of the site. The sources of the data are presented. Geological studies and investigations, boreholes and geophysical investigations prior to the construction of the Seelisbergtunnel (as well as all underground facilities pertaining to the said tunnel) are described. In the section devoted to geology, the stratigraphy and the tectonics of the helvetic nappes in the area of the site are described. Further, the host rock, the neighbouring formations and the local tectonics are presented. In conclusion the geological boundary conditions of the area are summarized. The section devoted to hydrogeology deals with the observations and measurements carried out at the surface and in the underground facilities. As well, the present state of knowledge concerning the water chemistry is described. The section also includes a description of the regional hydrogeology. Concerning rockmechanics a summary and discussion of all available parameters and excavation classes is presented. A description of all the experiences acquired during construction follows as a second part. The section ends with a presentation of the observations and measurements of the gas content of the host rock and other formations. A section concerning long-term behaviour concludes the report. Possible future changes of the geology and the climate are investigated. The consequences for the model site are discussed. It is concluded that a negative impact to a repository on the site is improbable on a timescale of 10^5 years. (author) 31 figs., 51 tabs., 170 refs.

27699 (NUREG/CR–5001) **Effects of manufacturing variables on performance of high-level waste low carbon steel containers: Final report.** Frost, R.H. (Colorado School of Mines, Golden, CO (USA)); Muth, T.R.; Liby, A.L. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Manufacturing Sciences Corp., Oak Ridge, TN (USA). Apr 1990. 116p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

Analytical and experimental research was performed to determine the effect of manufacturing variables on the performance of cast steel overpacks. The work examines the influence of casting and welding process variables on the long-term performance of low carbon steel overpacks in the repository environment. Centrifugal casting was indicated to be the most economical and technically favorable manufacturing approach for cast steel overpacks. A bottom would be welded into a hollow cylinder to make the container and final closure welding to secure the lid in place would be done at the repository. Effects of alloy chemistry, solidification processing, and solid state phase transformations on final microstructure of the cast and welded overpack has been examined in detail in this report. Experimental work focused on material and process combinations to be used in manufacture of overpacks. Practical process limits were explored and changes in microstructure due to repository thermal conditions were investigated.

27700 (NUREG/CR–5393) **A review of techniques for propagating data and parameter uncertainties in high-level radioactive waste repository performance assessment models.** Zimmerman, D.A. (GRAM, Inc., Albuquerque, NM (USA)); Wahl, K.K.; Gutjahr, A.L.; Davis, P.A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of High-Level Waste Management; Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 143p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–89-1432). Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

Techniques for propagating data and parameter uncertainties in high-level waste (HLW) repository performance assessment models are discussed. Uncertainty analysis techniques techniques ascribe quantitative measures of reliability to model predictions. Both 10 CFR 60 and 40 CFR 191 require consideration of uncertainties, including uncertainties in data and parameters, in the performance assessment of an HLW repository system. Four categories of uncertainty analysis methods are discussed: Monte Carlo simulation, replacement models (response surface techniques), differential techniques (direct, adjoint, and Green's function technique), and geostatistical techniques (stochastic modeling using Monte Carlo simulation and spectral analysis). Advantages, disadvantages and applications of each technique are presented. Propagation of uncertainties through multiple, linked models is also discussed. Application of these techniques to sensitivity analysis is also presented. Sensitivity analyses can be useful to uncertainty studies because the number of parameters included in the uncertainty analysis can be reduced by eliminating those parameters for which the uncertainty has a minimal effect on the performance variable(s).

27701 (NUREG/CR–5463) **Effects of mineralogy on sorption of strontium and cesium onto Calico Hills Tuff.** Meyer, R.E. (Oak Ridge National Lab., TN (USA)); Arnold, W.D.; Case, F.I.; O'Kelley, G.D.; Land, J.F. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Oak Ridge National Lab., TN (USA). Apr 1990. 31p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL–6589). Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

The sorption properties of tuff formations at the proposed site for the high-level nuclear waste repository at Yucca Mountain, Nevada, have been extensively studied. Sorption and desorption measurements were made of strontium and cesium onto clinoptilolite and Calico Hills Tuff. The object was to see whether there was a correlation between sorption of strontium and cesium onto Calico Hills Tuff and the sorption of strontium and cesium onto clinoptilolite based on the content of clinoptilolite in the Calico Hills Tuff. 13 refs., 10 figs., 6 tabs.

27702 (NUREG/CR–5517) **IMPACTS-BRC, Version 2.0: Program users's manual.** O'Neal, B.L. (Sandia National Labs., Albuquerque, NM (USA)); Lee, C.E. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Low-Level Waste Management; Applied Physics, Inc., Albuquerque, NM (USA); Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 239p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789.

(SAND–89-3060). Available from NTIS, PC A11/MF A01 - GPO; OSTI; INIS.

This manual describes the procedures for implementing IMPACT-BRC Version 2.0. IMPACTS-BRC is a generic, radiological assessment code intended to be used by the US Nuclear Regulatory Commission (NRC) to evaluate petitions to classify specific waste streams as below regulatory concern (BRC). The code is designed to demonstrate compliance to BRC standards by modeling and calculating annual radiological impacts to the maximal individual, critical groups, and the general population as the result of transportation treatment, disposal, and post-disposal activities involving low-level radioactive waste. Impacts are calculated for multiple nuclides and pathways depending on data input and treatment and disposal options specified by the code user. The treatment and disposal options include onsite incineration, offsite incineration at municipal and hazardous waste landfills. Included within the disposal options is the ability to calculate impacts from the sorting and/or recycling of metal containers and metal and glass materials. Nuclide-specific accounting is provided to facilitate identification of the critical nuclides and pathways contributing to the impacts. Default environmental and facility parameters are developed from reference treatment/disposal sites. The user has the option to replace default parameters with site-specific parameters to provide more realistic estimation of impacts. 8 refs., 10 figs., 44 tabs.

27703 (NUREG/CR–5547) **Application of surface complexation models for radionuclide adsorption: Sensitivity analysis of model input parameters.** Hayes, K.F. (Stanford Univ., CA (USA). Dept. of Civil Engineering); Redden, G.; Ela, W.; Leckie, J.O. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Low-Level Waste Management and Decommissioning; Stanford Univ., CA (USA). Dept. of Civil Engineering; Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 85p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC06-76RL01830. (PNL–7239). Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

This report discusses activity in two areas: an evaluation of methodologies currently used for the physical and chemical characterization of metal oxide and hydroxide adsorbents and the sensitivity of the various surface complexation models' adsorbent input parameters for describing adsorption. The report describes the relative merits of three surface complexation models (SCM), procedures to estimate values of the model parameters from titration data and what is required of experimental titration data sets. The ultimate goal is to determine how and whether SCMs can successfully describe adsorption of contaminants from disposed nuclear wastes in natural soils and sediment. This study's results help clarify the applicability of SCMs, particularly with respect to their sensitivity to input parameters. A method is presented by which unique, best fit values for these parameters may be obtained. An appendix is provided that reviews methods for determining surface area, site density, particle size distribution and pore structure. 17 refs., 13 figs., 23 tabs.

27704 (ORNL/M–1110) **Formerly Utilized Sites Remedial Action Program environmental compliance assessment checklists.** Levine, M.B.; Sigmon, C.F. Oak Ridge National Lab., TN (USA). 29 Sep 1989. 215p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90009446. Available from NTIS, PC A10/MF A01; OSTI; INIS; GPO Dep.

The purpose of the Environmental Compliance Assessment Program is to assess the compliance of Formerly Utilized Site Remedial Action Program (FUSRAP) sites with applicable environmental regulations and Department of Energy (DOE) Orders. The mission is to identify, assess, and decontaminate sites utilized during the 1940s, 1950s, and 1960s to process and store uranium and thorium ores in support of the Manhattan Engineer District and the Atomic Energy Commission. To conduct the FUSRAP environmental compliance assessment, checklists were developed that outline audit procedures to determine the compliance status of the site. The checklists are divided in four groups to correspond to these regulatory areas: Hazardous Waste Management, PCB Management, Air Emissions, and Water Discharges.

27705 (ORNL/Sub–86-SA094/4) **Supplement to ORNL/Sub/86-SA094/1 on use of transportable storage casks in the nuclear waste management system.** Oak Ridge National Lab., TN (USA); Johnson (E.R.) Associates, Inc., Oakton, VA (USA). Mar 1990. 86p. Sponsored by U.S. DOE Nuclear Energy; U.S. DOE Radioactive Waste Management. DOE Contract AC05-84OR21400. (JAI–315). Order Number DE90010236. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

This report is one of a series of eight prepared by E. R. Johnson Associates, Inc. (JAI) under ORNL's contract with DOE's OCRWM Systems Integration Program and in support of the Annual Capacity Report (ACR) Issue Resolution Process. The report topics relate specifically to the list of high priority technical waste acceptance issues developed jointly by DOE and a utility-working group. JAI performed various analyses and studies on each topic to serve as starting points for further discussion and analysis leading eventually to finalizing the process by which DOE will accept spent fuel and waste into its waste management system. The eight reports are concerned with the conditions under which spent fuel and high level waste will be accepted in the following categories: failed fuel; consolidated fuel and associated structural parts; non-fuel-assembly hardware; fuel in metal storage casks; fuel in multi-element sealed canisters; inspection and testing requirements for wastes; canister criteria; spent fuel selection for delivery; and defense and commercial high-level waste packages. This document discusses the use of transportable storage casks. 12 refs., 7 tabs.

27706 (ORNL/Sub–86-SA094/5) **Acceptance of failed SNF [spent nuclear fuel] assemblies by the Federal Waste Management System.** Oak Ridge National Lab., TN (USA); Johnson (E.R.) Associates, Inc., Oakton, VA (USA). Mar 1990. 127p. Sponsored by U.S. DOE Nuclear Energy; U.S. DOE Radioactive Waste Management. DOE Contract AC05-84OR21400. (JAI–325). Order Number DE90010226. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

This report is one of a series of eight prepared by E. R. Johnson Associates, Inc. (JAI) under ORNL's contract with DOE's OCRWM Systems Integration Program and in support of the Annual Capacity Report (ACR) Issue Resolution Process. The report topics relate specifically to the list of high priority technical waste acceptance issues developed jointly by DOE and a utility-working group. JAI performed various analyses and studies on each topic to serve as starting points for further discussion and analysis leading eventually to finalizing the process by which DOE will accept spent fuel and waste into its waste management system. The eight reports are concerned with the conditions under which spent fuel and high level waste will be accepted in the following categories: failed fuel; consolidated fuel and associated structural parts; non-fuel-assembly hardware; fuel in metal storage casks; fuel in multi-element sealed canisters; inspection and testing requirements for wastes; canister criteria; spent fuel selection for delivery; and defense and commercial high-level waste packages. This document discusses acceptance of failed spent fuel assemblies by the Federal Waste Management System. 18 refs., 7 figs., 25 tabs.

27707 (ORNL/Sub–86-SA094/7) **Acceptance of canisters of consolidated spent nuclear fuel by the Federal Waste Management System.** Johnson (E.R.) Associates, Inc., Oakton, VA (USA). Mar 1990. 103p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. (JAI–322). Order Number DE90010227. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

This report is one of a series of eight prepared by E. R. Johnson Associates, Inc. (JAI) under ORNL's contract with DOE's OCRWM Systems Integration Program and in support of the Annual Capacity Report (ACR) Issue Resolution Process. The report topics relate specifically to the list of high priority technical waste acceptance issues developed jointly by DOE and a utility-working group. JAI performed various analyses and studies on each topic to serve as starting points for further discussion and analysis leading eventually to finalizing the process by which DOE will accept spent fuel and waste into its waste management system. The eight reports are concerned with the conditions under which spent fuel and high level waste will be accepted in the following categories: failed fuel;

consolidated fuel and associated structural parts; non-fuel-assembly hardware; fuel in metal storage casks; fuel in multi-element sealed canisters; inspection and testing requirements for wastes; canister criteria; spent fuel selection for deliver; and defense and commercial high-level waste packages. This document discusses canister standards and criteria. 12 refs., 7 figs., 28 tabs.

27708 (ORNL/Sub–86-SA094/8) **Acceptance of non-fuel assembly hardware by the Federal Waste Management System.** Oak Ridge National Lab., TN (USA); Johnson (E.R.) Associates, Inc., Oakton, VA (USA). Mar 1990. 127p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC05-84OR21400. (JAI–328). Order Number DE90010222. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

This report is one of a series of eight prepared by E. R. Johnson Associates, Inc. (JAI) under ORNL's contract with DOE's OCRWM Systems Integration Program and in support of the Annual Capacity Report (ACR) Issue Resolution Process. The report topics relate specifically to the list of high-priority technical waste acceptance issues developed jointly by DOE and a utility-working group. JAI performed various analyses and studies on each topic to serve as starting points for further discussion and analysis leading eventually to finalizing the process by which DOE will accept spent fuel and waste into its waste management system. The eight reports are concerned with the conditions under which spent fuel and high-level waste will be accepted in the following categories: failed fuel; consolidated fuel and associated structural parts; non-fuel-assembly hardware; fuel in metal storage casks; fuel in multi-element sealed canisters; inspection and testing requirements for wastes; canister criteria; spent fuel selection for delivery; and defense and commercial high-level waste packages. 14 refs., 12 figs., 43 tabs.

27709 (PB–90-860503/XAB) **Radioactive waste processing: Fixation in cements and bitumens. November 1973-February 1990 (A Bibliography from the NTIS data base). Report for November 1973-February 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 116p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the fixation or solidification of radioactive wastes using cements, bitumens, or asphalts. Formulation, physical strength, degradation, and leachability of these materials are presented. Full scale production plants are described. Gaseous wastes, nitrate salts, borate salts, spent fuels, contaminated soils, sludges, and liquid wastes can be solidified in these materials. Vitrification processes for radioactive waste disposal are discussed in a separate bibliography. (Contains 217 citations fully indexed and including a title list.)

27710 (PB–90-860529/XAB) **Radioactive waste processing: Borosilicate glasses and synthetic rocks. June 1977-February 1990 (A Bibliography from the NTIS data base). Report for June 1977-February 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 105p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning radioactive waste processing and disposal by incorporation in borosilicate glasses and synthetic rock materials. Formulations, leach tests and evaluations, melting characteristics, phase determinations, scaled-up processes and process variables including the Synroc process, and general preparation and evaluation studies are included. Waste vitrification in materials other than borosilicates and synthetic rocks, and waste fixation using cements and bitumens are discussed in separate bibliographies. (Contains 193 citations fully indexed and including a title list.)

27711 (PB–90-860602/XAB) **Radioactive waste processing: Vitrification. November 1973-October 1989 (A Bibliography from the NTIS data base). Report for November 1973-October 1989.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 122p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the processing of radioactive wastes by vitrification or the formation of a glassy material to immobilize radioactive nuclides. International waste vitrification programs; in-situ vitrification; proposed glass compositions; glass properties including degradation, leachability, and physical strength; and vitrification processes are discussed. Full-scale vitrification plants are described. Solidification of radioactive waste with borosilicate glass and synthetic rock or with cement and asphalt is discussed in separate bibliographies. (Contains 247 citations fully indexed and including a title list.)

27712 (PNL–7152) **Test plan for hydrologic modeling of protective barriers.** Fayer, M.J. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 41p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90009353. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Pacific Northwest Laboratory prepared this test plan for the Model Applications and Validation Task of the Hanford Protective Barriers Program, which is managed by Westinghouse Hanford Company. The objectives of this plan are to outline the conceptual hydrologic model of protective barriers, discuss the available computer codes, describe the interrelationships between the modeling task and the other tasks of the Protective Barriers Program, present the barrier modeling tests, and estimate the schedule and costs of the hydrologic modeling task for planning purposes by the Protective Barriers Program. The purpose of the tests is to validate models that will be used to confirm the long-term performance of the barrier in minimizing drainage. A second purpose of the tests is to provide information to other parts of the Protective Barriers Program that require such information. 26 refs., 2 figs., 3 tabs.

27713 (PNL–7282) **Water-table elevations on the Hanford Site, June 1989.** Newcomer, D.R.; McDonald, J.P.; Goodwin, S.M. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 43p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-76RL01830. Order Number DE90009355. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Site Characterization and Assessment Section, Geosciences Department, of the Pacific Northwest Laboratory (PNL) prepares water-table maps of the Hanford Site. Water levels in selected wells open to the unconfined aquifer on the Hanford Site are measured in June and December of each year. The purpose of these measurements is to determine the changes in the configuration of the water table to assess the physical impact of waste disposal on ground-water flow. Water levels are measured in wells that monitor the unconfined aquifer. The wells used to measure water levels were chosen based on geologic and hydrologic information available for Hanford. 15 refs., 4 figs.

27714 (PNL–7305) **RCRA [Resource Conservation and Recovery Act] ground-water monitoring projects for Hanford facilities: Annual progress report for 1989.** Smith, R.M.; Gorst, W.R. (eds.). Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 145p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-76RL01830. Order Number DE90010004. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This report describes the progress during 1989 of 16 Hanford Site ground-water monitoring projects covering 25 hazardous waste facilities and 1 nonhazardous waste facility. Each of the projects is being conducted according to federal regulations based on the Resource Conservation and Recovery Act of 1976 and the State of Washington Administrative Code. 40 refs., 75 figs., 6 tabs.

27715 (PNL–7306-Vol.1) **Resource Conservation and Recovery Act ground-water monitoring projects for Hanford facilities: Progress report for the period October 1 to December 31, 1989: Volume 1, Text.** Smith, R.M.; Bates, D.J.; Lundgren, R.E. (eds.). Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 368p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-76RL01830. Order Number DE90009823. Available from NTIS, PC A16/MF A01 - OSTI; GPO Dep.

This is Volume 1 of a two-volume document that describes the progress of 15 Hanford Site ground-water monitoring projects for the period October 1 to December 31, 1989. This volume discusses the projects. The work described in this document is conducted by the Pacific Northwest Laboratory under the management of Westinghouse Hanford Company for the US Department of Energy. Concentrations of ground-water constituents are compared to federal drinking water standards throughout this document for reference purposes. All drinking water supplied from the samples

aquifer meets regulatory standards for drinking water quality. 51 refs., 35 figs., 86 tabs.

27716 (PNL–7306-Vol.2) **Resource Conservation and Recovery Act ground-water monitoring projects for Hanford Facilities: Progress report, October 1–December 31, 1989: Volume 2, Appendixes.** Smith, R.M.; Bates, D.J.; Lundgren, R.E. (eds.). Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 700p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-76RL01830. Order Number DE90009824. Available from NTIS, PC A99/MF A01 - OSTI.

This Volume 2 of a two-volume set of documents that describes the progress of 15 Hanford Site ground-water monitoring projects for the period October 1 to December 31, 1989. This volume provides well completion information to supplement information included in the previous quarterly report and as-built diagrams, well completion/inspection reports, drilling logs, and geophysical logs for wells drilled during this quarter near the Single-Shell Tanks.

27717 (PNL-SA–17402) **Three-dimensional plume dynamics in the vadose zone: PORFLO-3 modeling of a defense waste leak at Hanford.** Smoot, J.L.; Sagar, B. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. (CONF-900406–69: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90009403. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In 1973, approximately 450 m^3 of liquid containing radioactive and chemical wastes leaked from the 241-T-106 single-shell tank into the vadose zone at the US Department of Energy's Hanford Site in south-central Washington State. The extent of the ^{137}Cs, ^{144}Ce, and ^{106}Ru contaminant plumes in the vadose zone was estimated in 1973 and 1978 by gamma spectrometry in monitoring wells. Using site data and the PORFLO-3 computer model, a three-dimensional, transient plume migration model was developed for ^{106}Ru and ^{137}Cs. The model was calibrated to the 1973 measured plumes of ^{106}Ru and ^{137}Cs. The calibrated model was then used to study plume migration up to 1990. The simulated ^{106}Ru distribution for 1978 extended deeper than reported values. The simulated distribution of ^{137}Cs for 1978 approximated the measured distribution; the 1973 and 1978 ^{137}Cs distributions are similar because of the long half-life and high sorption coefficient of ^{137}Cs. 8 figs., 15 refs.

27718 (PNL-SA–17523) **The coordination of system representation and operating assumptions for system studies in SIMS [System Integration Modeling System].** McKee, R.W. (Pacific Northwest Lab., Richland, WA (USA)); Short, S.M. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 8p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830. (CONF-900406–68: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90009458. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Two projects at the Pacific Northwest Laboratory (PNL) have been devoted to development of the capability to provide descriptive details of the Federal Waste Management System (FWMS) and its operating rules for comprehensive system studies. This capability is designed to provide consistency in the selection of the bases and assumptions for System Integration Program studies and related computer modeling activities. The System Description Project has developed a modular system description approach that can be used to quickly prepare specific detailed system descriptions once a study-specific system configuration has been defined. The Operational Scenarios and Assumptions (OSA) Project has developed a menu-driven database system that provides a comprehensive and systematic method for specifying the necessary assumptions and system operating rules for specific system studies. The viability of these capabilities has been demonstrated in a system modeling exercise. 6 refs., 3 figs., 1 tab.

27719 (PNL-SA–17574) **Effects of water composition on the dissolution rate of UO_2 under oxidizing conditions.** Wilson, C.N.; Gray, W.J. Pacific Northwest Lab., Richland, WA (USA). Dec 1989. 6p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830. (CONF-900406–67: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90009457. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Dissolution rates were measured on crushed unirradiated UO_2 fuel pellet samples under oxidizing conditions using a flow-through testing method. A thin U–Si–O surface alteration layer was identified by Auger microprobe examination of UO_2 particles tested at 25°C in Ca–Si-containing waters, and a thin layer containing Ca + Si was identified on the surface of particles tested at 85°C. These experiments and their preliminary results are discussed as they apply to the potential disposal of spent nuclear fuel at the candidate Yucca Mountain repository site. 3 refs., 6 figs., 11 tabs.

27720 (POEF-T–3525) **Optimization study of the X-700 Biodenitrification Plant.** Plecenik, M.S. Martin Marietta Energy Systems, Inc., Piketon, OH (USA). 30 Mar 1990. 63p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-76OR00001. Order Number DE90009546. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Biodenitrification Facility at the Portsmouth Gaseous Diffusion Plant was designed to remove nitrate-nitrogen from waste solutions generated by the X-705 Decontamination and Solution Recovery Facility. The new NPDES permit for this facility, NPDES outfall 604, required that an operational optimization study be conducted after the permit was issued. This report documents the second half of the optimization study, the first part of which is documented in POEF-P-128, "Operational Optimization of the X-700 Biodenitrification Plant — Preliminary Report", December 30, 1988. The purpose of this study was to determine the process capability of the New Biodenitrification Facility. The goal was to determine if the facility could be operated to process the design amount of waste solutions without exceeding the proposed effluent limits. Optimization activities focused on controlling the feed to the first column to maximize the removal of nitrate-nitrogen and on complying with existing effluent permit limits.

27721 (SAND–86-0090) **The thermal conductivity of the Topopah Spring Member at Yucca Mountain, Nevada: Yucca Mountain Project.** Nimick, F.B. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 64p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. Order Number DE90010247. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

Measured thermal-conductivity data are summarized for 15 samples of the Topopah Spring Member from Yucca Mountain. Modeling results for the saturation history of thermal-conductivity-experiment samples are presented; the saturation of these samples may be 0.5 or greater even after an experiment is completed. Thus, only the data from low-temperature measurements have been used to obtain estimates of matrix thermal conductivities and then of in situ (rock mass) values for thermal conductivity. The estimated in situ values for Units TSw1 and TSw2 are consistent with experiment data obtained by other investigators. 23 refs., 13 figs., 7 tabs.

27722 (SAND–88-0474) **G-Tunnel welded tuff mining experiment data summary: Yucca Mountain Project.** Zimmerman, R.M. (Sandia National Labs., Albuquerque, NM (USA)); Bellman, R.A. Jr.; Mann, K.L.; Zerga, D.P.; Fowler, M. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 93p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. Order Number DE90010246. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

Designers and analysts of radioactive waste repositories must be ably to predict the mechanical behavior of the host rock. Sandia National Laboratories elected to conduct a mine-by in welded tuff so that predictive-type information could be obtained regarding the response of the rock to a drill and blast excavation process, where smooth blasting techniques were used. Included in the study were evaluations of and recommendations for various measurement systems that might be used in future mine by efforts. This report summarizes all of the data obtained in the welded tuff mining experiment. 6 refs., 29 figs., 12 tabs.

27723 (SAND–89-0011) **Studies of computational models for jointed media with orthogonal sets of joints.** Koteras, J.R. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 43p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. Order Number DE90008202. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report examines the computational implementation of a continuum model for jointed rock media. The jointed rock model uses strain partitioning between the elastic rock matrix and joint sets with nonlinear normal and shear responses. A specific model using a rational polynomial to describe normal joint response was first used as the basis for a computational implementation of a jointed rock model for two-dimensional problems. This particular implementation can be extended to three dimensions, but it would be a very expensive material model from a computational standpoint. The problem of trying to implement a joint model in three dimensions so that it would not be an extremely expensive computational tool has led to a study of various computational implementations of joint models for two-dimensional geometries. These studies have produced implementations of joint models that are very computationally efficient and that can handle joint models with normal joint behavior described by general relations. The implementations studied in this report make the use of jointed rock models in three dimensions much more feasible in terms of computational expense. 6 refs., 8 figs., 2 tabs.

27724 (SAND–89-1441C) **Numerical analyses of the G-tunnel mining evaluations experiment.** Bauer, S.J. (Sandia National Labs., Albuquerque, NM (USA)); Costin, L.S.; Johnson, R.L. Sandia National Labs., Albuquerque, NM (USA). [1990]. 15p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-9004171–2: International conference of jointed and faulted rock, Vienna (Austria), 18-20 Apr 1990). Order Number DE90009321. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The displacements resulting from excavation of a drift in layered tuffs at Rainier Mesa, Nevada, have been analyzed. Also, a series of two-dimensional finite-element analyses of the excavation sequence using linear elastic and nonlinear compliant joint material models has been made. Measured displacements were on the order of millimeters and show vertical and horizontal closure. Calculated displacements are also on the order of millimeters; vertical and horizontal closure is predicted in some of the analyses performed. 5 refs., 3 figs., 3 tabs.

27725 (SAND–89-1765C) **Rock-mass experiments on jointed welded tuff.** Hansen, F.D.; Finley, R.E.; George, J.T. Sandia National Labs., Albuquerque, NM (USA). [1990]. 9p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-9004171–1: International conference of jointed and faulted rock, Vienna (Austria), 18-20 Apr 1990). Order Number DE90009326. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Field tests emphasizing development and demonstration of equipment and instruments are part of Sandia National Laboratories' rock mechanics program. The successful conduct of demonstration tests has allowed assessment of test techniques and an evaluation of the mechanical behavior of jointed welded tuff. The most recent endeavor consisted of high-pressure flatjack test yielding load and deformation histories sufficient to evaluate rock-mass modulus and to provide in situ results against which analytical models can be compared. Test results were used to calculate rock-mass moduli which compare favorably with previous estimates for jointed welded tuff. 6 refs., 7 figs., 1 tab.

27726 (SAND–89-2146C) **Application of models for jointed rock to the analysis of prototype testing for the Yucca Mountain Project.** Costin, L.S. Sandia National Labs., Albuquerque, NM (USA). [1990]. 12p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-900646–9: 31. US symposium on rock mechanics, Golden, CO (USA), 18-20 Jun 1990). Order Number DE90006807. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A combined experimental and analytical approach to the development of jointed rock mass characterization and modeling methods for the Yucca Mountain Project is being pursued at Sandia National Laboratories. Techniques for loading a significant portion of the rock mass near a drift boundary are being developed and tested in the welded tuff units in G-Tunnel at the Nevada Test Site. Several of the test methods under consideration involve the use of large flatjacks, inserted into narrow slots cut in the walls or floor of a drift, to provide a controlled means to load a volume of rock. This paper presents an example of the application of models for jointed rock mass behavior to the analysis of flatjack tests conducted in G-Tunnel. Detailed numerical analyses of some of the flatjack tests are being performed to assist the experimenters in developing the test procedure and as part of an effort to develop and evaluate numerical models that can be used for the site characterization and performance assessment activities at Yucca Mountain. These analyses were performed using both a linear model with a reduced modulus to simulate joint effects and a recently developed compliant joint rock mass model, which takes into account the spacing, orientation, and shear and normal displacement behavior of two orthogonal joint sets. Comparisons between the linear and nonlinear analytical methods and between the analytical and experimental results are presented. These comparisons allow one to evaluate the utility of the available analytical methods and to suggest possible improvements to both the analytical and experimental techniques. 8 refs., 6 figs., 1 tab.

27727 (SAND–89-2175C) **The influence of large, cold objects on engulfing fire environments.** Nicolette, V.F.; Larson, D.W. Sandia National Labs., Albuquerque, NM (USA). [1989]. 28p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900619–2: 5. AIPA/ASME thermophysics and heat transfer conference, Seattle, WA (USA), 18-20 Jun 1990). Order Number DE90003342. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Appropriate thermal boundary conditions for analytical predictions of the thermal response of large, cold objects (such as nuclear spent-fuel shipping casks) engulfed in flames are not well understood. These objects have been shown experimentally to respond differently to engulfing flames than small calorimeters, and traditional scaling parameters are not successful in explaining these observed differences. One possible explanation is that a large, cold object interacts with and cools the surrounding flames, resulting in lower incident heat fluxes to the large object. A simple model is constructed to investigate this hypothesis. Results of calculations with the model indicate that such an interaction does occur and can significantly reduce incident heat fluxes to large objects. This implies that appropriate thermal boundary conditions for large, cold objects engulfed in flames are dependent on the size, shape, and thermal response of the object. 10 refs., 13 figs.

27728 (SAND–89-2268C) **Comparison of calculations and in situ results for a large, heated test room at the Waste Isolation Pilot Plant (WIPP).** Munson, D.E. (Sandia National Labs., Albuquerque, NM (USA)); DeVries, K.L.; Callahan, G.D. Sandia National Labs., Albuquerque, NM (USA). [1989]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900646–1: 31. US symposium on rock mechanics, Golden, CO (USA), 18-20 Jun 1990). Order Number DE90005953. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In summary, through thermal/structural calculations and detailed comparisons of the results of a large scale, in situ heated experiment at the WIPP facility, it should be possible to validate the temperature dependence of room deformation. The experiment, when used in conjunction with an identical experimental room which was unheated, is very specific to only the thermal portions of the calculational model. 4 refs., 6 figs.

27729 (SAND–89-2282C) **Analysis of WIPP [Waste Isolation Pilot Plant] disposal room and entryway drift intersection.** Argueello, J.G. Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900646–4: 31. US symposium on rock mechanics, Golden, CO (USA), 18-20 Jun 1990). Order Number DE90005427. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A three-dimensional finite element structural analysis of the intersection of a typical disposal room and entryway drift at the WIPP

has been performed. This analysis reveals how complicated underground openings, truly 3D in nature, respond in a creeping medium, and the response may appear anomalous to those with a "hard rock" background. Computed closures at the intersection are presented and compared to available in situ data. A qualitative agreement between measured and computed closures is seen. 9 refs., 8 figs.

27730 (SAND–89-2322) **Investigation of an empirical creep law for rock salt that uses reduced elastic moduli.** Morgan, H.S. (Sandia National Labs., Albuquerque, NM (USA)); Krieg, R.D. Sandia National Labs., Albuquerque, NM (USA). [1989]. 8p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-900646–2: 31. US symposium on rock mechanics, Golden, CO (USA), 18-20 Jun 1990). Order Number DE90004163. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Early attempts to predict the creep response of rock salt around underground rooms at the Waste Isolation Pilot Plant (WIPP) produced closure estimates that were one-third to one-fourth of values measured in situ (Morgan et. al., 1985). A subsequent study (Morgan, et al., 1986) of the WIPP reference elastic secondary creep model (Krieg, 1984) used to make these predictions revealed that room closures and even closure rates could be increased by reducing the elastic constants. This study also indicated that a vertical cylindrical shaft configuration could be substituted for more complicated and expensive rectangular room configurations in studying constitutive parameters for rock salt. Sjaardema and Krieg (1986) used these results to determine how much the WIPP reference value of Young's modulus E had to be reduced to increase the creep closure and closure rate of a hypothetical borehole in rock salt by factors of 3.5 to 4. They found that E had to be divided by 12.5 to produce the desired results. 12 refs., 5 figs.

27731 (SAND–89-2347C) **Scale effects in the shear behavior of joints in welded tuff.** Blejwas, T.E.; Hansen, F.D. Sandia National Labs., Albuquerque, NM (USA). [1990]. 6p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-900640–1: International conference on rock joints, Loen (Norway), 4-6 Jun 1990). Order Number DE90008461. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Any opening instabilities in a possible nuclear waste repository at Yucca Mountain, Nevada, are likely to be the result of movements along pre-existing joints in welded tuffs. Preliminary analyses suggest some potential for joint shear, but data are not available for evaluating the effect that large joint irregularities have on limiting displacements. Tests using sample sizes up to those that yield dilations and normal forces representative of in situ conditions are desirable for the proper characterization of shear behavior along irregular joints. A program of laboratory and field experiments will investigate the coupled effects of sample size and normal boundary conditions on shear behavior of joints in welded tuffs. This paper discusses this program. 15 refs., 4 figs.

27732 (SAND–89-2359C) **Laboratory research program to aid in developing and testing the validity of conceptual models for flow and transport through unsaturated porous media.** Glass, R.J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 10p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-9005117–5: GEOVAL '90, Stockholm (Sweden), 14-17 May 1990). Order Number DE90009532. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

As part of the Yucca Mountain Project, a laboratory research program is being developed at Sandia National Laboratories that will integrate fundamental physical experimentation with conceptual formulation and mathematical modeling and aid in subsequent model validation for unsaturated zone water and contaminant transport. Experimental systems are being developed to explore flow and transport processes and assumptions of fundamental importance to various conceptual models. Experimentation will run concurrently in two types of systems: fractured and nonfractured tuffaceous systems; and analogue systems having specific characteristics of the tuff systems but designed to maximize experimental control and resolution of data measurement. Questions to which experimentation currently is directed include infiltration flow instability, water and solute movement in unsaturated fractures, fracture-matrix interaction, and the definition of effective large-scale properties for heterogeneous, fractured media. 16 refs.

27733 (SAND–89-2446C) **The effects of shear and normal stress paths on rock friction.** Olsson, W.A. Sandia National Labs., Albuquerque, NM (USA). [1990]. 6p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-900640–2: International conference on rock joints, Loen (Norway), 4-6 Jun 1990). Order Number DE90007214. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The effect of variable normal stress on the coefficient of friction of smooth artificial surfaces in welded tuff was studied. The shear stress response to changes in normal stress during constant-velocity sliding suggests that friction depends on the history of the normal stress; or, more generally, the path in shear/normal stress space. 6 refs., 5 figs.

27734 (SAND–89-7067) **Analysis of the fluid-pressure responses of the Rustler Formation at H-16 to the construction of the air-intake shaft at the Waste Isolation Pilot Plant (WIPP) site.** Alvis, J.D.; Saulnier, G.J. Jr. Sandia National Labs., Albuquerque, NM (USA); INTERA, Inc., Austin, TX (USA). Mar 1990. 167p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010245. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The construction of the air-intake shaft (AIS) at the Waste Isolation Pilot Plant (WIPP) site in 1987 and 1988 initiated fluid-pressure responses which were used to estimate the hydrologic properties of the Culebra Dolomite, Magenta Dolomite, and Forty-niner Members of the Rustler Formation. Fluid-pressure responses were monitored with downhole transducers. The AIS pilot hole,remained open and draining to the underground facility for about three months. The pilot hole was then upreamed from the underground facility to land surface. The pilot hole was drilled and reamed using a bentonite-mud-based brine as a drilling fluid. The well-test simulator GTFM was used to analyze the fluid-pressure responses of the Culebra and Magenta dolomites and the Forty-niner claystone. A cement-invasion skin was used in simulating the Culebra dolomite's drilling/reaming period. A mud-filter-cake skin was used to create reduced wellbore pressures in simulating the pilot-hole drilling/reaming periods of the Magenta dolomite and Forty-niner claystone. 26 refs., 70 figs., 10 tabs.

27735 (UCID–21869) **Geochemical modeling of radioactive waste glass dissolution using EQ3/6: Preliminary results and data needs.** Bourcier, W.L. Lawrence Livermore National Lab., CA (USA). Jan 1990. 37p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90009513. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A kinetic model for the dissolution of borosilicate glass has been incorporated into the EQ3/6 geochemical modeling code. The model consists of three main parts; (1) a kinetic rate law based on thermodynamics and the principle of detailed balancing for predicting the rate of glass dissolution; (2) a modified version of the hydration theory of Plodinec and Jantzen for calculating glass dissolution affinity; and (3) secondary phase precipitation. The model predicts the solution composition including pH and Eh as a function of time, and the amounts and types of secondary phases that form during glass dissolution. Steady state conditions are assumed where an early-formed leached layer develops on the glass surface and maintains a constant thickness as the glass dissolves. The model has been used to predict the performance of SRL-165 glasses in static leach tests performed for the Yucca Mountain Project at Argonne National Laboratory.

27736 (UCRL–101107) **A kinetic model for borosilicate glass dissolution based on the dissolution affinity of a surface alteration layer.** Bourcier, W.L.; Peiffer, D.W.; Knauss, K.G.; McKeegan, K.D.; Smith, D.K. Lawrence Livermore National Lab., CA (USA). Nov 1989. 10p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. (CONF-891119–118: Materials Research Society fall meeting, Boston, MA (USA), 27 Nov - 2 dec 1989). Order Number DE90009435. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A kinetic model for the dissolution of borosilicate glass is used to predict the dissolution rate of a nuclear waste glass. In the model, the glass dissolution rate is controlled by the rate of dissolution of an alkali-depleted amorphous surface (gel) layer. Our model predicts that all components concentrated in the surface layer, affect glass dissolution rates. The good agreement between predicted and observed elemental dissolution rates suggests that the dissolution rate of the gel layer limits the overall rate of glass dissolution. The model predicts that the long-term rate of glass dissolution will depend mainly on ion concentrations in solution, and therefore on the secondary phases which precipitate and control ion concentrations. 10 refs., 5 figs., 1 tab.

27737 (UCRL–102114) **Status of integrated performance assessment of the waste packages and engineered barrier system.** O'Connell, W.J. Lawrence Livermore National Lab., CA (USA). Jan 1990. 8p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-48. (CONF-900406–63: International conference for high-level radioactive waste management, Las Vegas, NV (USA), 8-12 Apr 1990). Order Number DE90009408. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Performance assessment of the engineered barrier system for a nuclear waste repository combines information from relevant disciplines and predicts the net long-term performance of the EBS in unites of regulatory goals for performance. The performance assessment models are specific to the proposed Yucca Mountain, Nevada site. Early assessments are used for project planning and feedback. The EBS scenarios activity develops the scenarios and the consequent event sequences. Initial model development for single waste packages indicates that the radionuclide release rate performance is sensitive to the water flux, element solubilities, and/or the mode of water contact with the waste. The latter in turn depends on local scale hydrology and the modes of corrosion for the container material. For the release rate summed over waste packages, variations among waste packages and their near-field environments are anticipated. These variations place demands on data acquisition and modeling, as well as modulate the impact of localized changes of conditions. Sampling in uncertainty assessment is a subsequent step in examining the reliability of predictions made in the performance assessments. Advances made in sampling methods are referenced. 14 refs., 6 figs.

27738 (WHC-EP–0300) **Alternatives to land disposal of solid radioactive mixed wastes on the Hanford Site.** Jacobsen, P.H.; Duncan, D.R. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 62p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. Order Number DE90008209. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report was prepared in response to Hanford Federal Facility Agreement and Consent Order to provide annual reports of studies/efforts that are in progress to identify alternatives to land disposal of radioactive mixed wastes (RMW). The annual reports will provide information regarding actions taken to minimize waste generation, recycle/reclaim wastes, or treat wastes. The scope of the report is "solid" waste. This is the first of such annual reports. It will summarize Hanford Site efforts to employ alternatives to land disposal of RMW, which contain both radioactive and hazardous constituents, by reviewing waste minimization and treatment plans, activities, and other related waste management activities presently and in future work. This report will be current as of the first quarter of fiscal year (FY) 1990. 9 refs., 4 figs., 1 tab.

27739 (WHC-EP–0324) **Restart of the 242-A Evaporator: Effluent retention, treatment, and disposal facilities program plan.** Lini, D.C.; Forehand, G.D.; Kelley, D.E. Westinghouse Hanford Co., Richland, WA (USA). Apr 1990. 29p. Sponsored by U.S. DOE Office of Environmental Restoration and Waste Management. DOE Contract AC06-87RL10930. Order Number DE90008208. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Operation of the 242-A Evaporator supports waste management activities including single-shell tank stabilization, grout processing, waste pretreatment before disposal, and production waste storage. In April 1989, the 242-A Evaporator was placed in temporary standby pending resolution of issues on the disposal of potential regulated dangerous wastes that may be in the 242-A effluent. Restart of the evaporator is required by December 1990, to maintain adequate double-shell tank space for storage of new generated wastes. A liquid effluent retention facility will be constructed to store the 242-A process condensate until a treatment and disposal facility is constructed and placed in operation. The liquid effluent retention facility will include basins for storing two effluent streams from the plutonium-uranium extraction operation that will be treated in the same facility before disposal. The liquid effluent retention facility is scheduled to be operational be December 1990, and the treatment and disposal facilities are scheduled to be operational by June 1992. 18 refs., 6 figs., 1 tab.

27740 (WHC-EP–0331) **Defense waste and environmental restoration programs: Fiscal year 1990 quarterly status.** Sargent, J.A. Westinghouse Hanford Co., Richland, WA (USA). Jan 1990. 230p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90008200. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

The reporting for this month is to introduce the format of the report, to state its basis, and to provide a current status of the financial data. The basis for the report is the workscope and work breakdown structure (WBS) associated with activity data sheets (ADS) which are prepared to support the US Department of Energy-Headquarters five year planning process. This report reflects information as submitted in the December 1989 submittal of the five-year plan. As changes are made to the milestone assignation and to inclusion in Tri-Party Agreement (TPA) scope in the final approved plan, the information presented will also change. The report format is intended to reflect the work assigned by program for the appropriate interim or major milestone.

27741 (WHC-SA–0560) **Application of remote nondestructive test methods for quality verification of grouted radioactive waste.** Benny, H.L. (Westinghouse Hanford Co., Richland, WA (USA)); Olson, L.D. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 25p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. (CONF-9004168–1: American Concrete Institute spring conference, Ontario (Canada), 18-23 Apr 1990). Order Number DE90009628. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Grout Disposal Program at Hanford will dispose of low level radioactive mixed wastes as a grout in near surface disposal vaults. Because of the activity level of the grouted waste, direct physical measurement of product quality is difficult. A program of remote, nondestructive testing has been initiated to verify the quality of the grouted waste produced. This paper describes the development of pulse velocity testing methods for verification of grout quality. The three methods evaluated include Ultrasonic Pulse Velocity, Crosshole Sonic Logging, and Mechanical Crosshole Seismic tests. Ultrasonic pulse velocity transducer arrays were cast into the grouted waste at known locations. The pulse velocity was measured as a function of time. Crosshole sonic logging was conducted between four tubes cast into the grout. The mechanical crosshole seismic tests utilized the same tubes, but utilized mechanical means to generate shear and compression waves. 12 figs., 3 tabs.

27742 (WHC-SA–0891) **Defense waste tank storage at the Hanford Site.** DiLiberto, A.J. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 20p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-87RL10930. (CONF-900676–2: 83. annual meeting and exhibition of the Air and Waste Management Association, Pittsburgh, PA (USA), 24-29 Jun 1990). Order Number DE90009135. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The defense liquid waste storage facilities at the Hanford Site in southcentral Washington State contain radioactive and hazardous chemical wastes generated by 45 yrs of nuclear fuel reprocessing. Current activities involve technology development for waste minimization, storage, treatment, and disposal. The double-shell tank waste will be retrieved, pretreated and separated into a high-level (HLW), transuranic (TRU), and low-level (LLW) fractions. The HLW and TRU fractions will be vitrified in a glass matrix and shipped to a geologic repository. The LLW fraction will be immobilized in grout and disposed of in a near-surface concrete vault on the Hanford

Site. The single-shell tank wastes are being characterized to support technology development to define a final disposal alternative. 8 refs., 6 figs.

27743 (WHC-SP–0221) **Project H-797, N Reactor 1312-N Liquid Effluent Retention Facility, reanalysis and documentation of design bases.** Paasch, R.A. (comp.). Westinghouse Hanford Co., Richland, WA (USA). Jan 1988. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE90009502. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The 1312-N Liquid Effluent Retention Facility (LERF) was constructed in 1987 to provide a means to contain liquid effluents that might be discharged from the reactor building during a severe loss-of-coolant accident. This facility responds to recommendations made by members of the Roddis Panel in its review of reactor safety issues and of the NAS Committee in its review of reactor technical issues to provide a means to contain accident effluents. The NAS Committee also voiced specific concerns from discharging such effluents directly to the environment. This report provides a summary of the reanalysis and documentation of the design bases for the LERF. Also, specific concerns of the NAS Committee, dealing primarily with radioiodine releases into the atmosphere from a non-confining structure are addressed. Compliance to acceptance criteria established for the project is discussed and noted. 22 refs., 1 fig.

27744 (WHC-SP–0463) **Hanford waste vitrification plant project plant acquisition plan.** Morson, R.B. Westinghouse Hanford Co., Richland, WA (USA). Oct 1989. 247p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90009501. Available from NTIS, PC A11/MF A01 - OSTI.

The fundamental goal of the Defense Waste Management Plan (DWMP) is to end present interim storage practices for defense wastes and to provide for permanent disposal. To achieve this goal, the DWMP establishes, as an objective, that high-level waste (HLW) be immobilized before shipment to a geologic repository. The Hanford Waste Vitrification Plant (HWVP) Project was established to accomplish this objective. The Hanford Waste Vitrification Plant Project Plant Acquisition Plan was developed to provide a basis for the configuration of the design, construction, and procurement packages. Another, and equally important, criterion is to establish the method of contracting and type of purchasing to be used. This document provides an overview of the procurement/construction logic and the schedule relating the two activities. A final part of the Plant Acquisition Plan will be to provide a cost estimate summary of the procurement packages. 7 refs., 1 fig.

27745 (WSRC-RP–89-0920) **Evaluation of closure capping on groundwater flow and solute transport at the General Separations Area: Flow model and particle-tracking analysis of closure caps with runoff.** Haselow, J.S. (Geraghty and Miller Modeling Group, Reston, VA (USA)); Lewis, C.M. Westinghouse Savannah River Co., Aiken, SC (USA); Geraghty and Miller Modeling Group, Reston, VA (USA). 20 Sep 1989. 54p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009125. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Groundwater flow modeling was performed to investigate the total response of the flow system in the General Separations Area at Savannah River Site (SRS) to closure capping and resulting runoff. An existing regional three-dimensional flow model for the general Separations Area simulated groundwater flow in four aquifer and three aquitard units. A predictive simulation was performed to forecast groundwater flow system response to a 90% efficient soil cap and the resulting precipitation runoff infiltration. 7 refs., 29 figs., 2 tabs.

27746 (WSRC-RP–89-955) **Accident analysis, nitrogen supply and purge systems: In-Tank Precipitation process, Savannah River Site.** Westinghouse Savannah River Co., Aiken, SC (USA). Nov 1989. 140p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009264. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

High-level liquid wastes (HLLW) from the processing of nuclear material at the Savannah River Site (SRS) are stored in large tanks in the F- and H-Area tank farms. In the tanks the wastes separate into sludge and salt solution. The salt solution is concentrated by evaporation and the salt and sludge are held for further processing. The ITP process decontaminates the salt solution so that it can be transferred to other storage facilities. The processing facility includes four large tanks, a filter building, an organic stripper building, filtrate hold tanks, and a cold chemical storage area. The nitrogen inerting system providesa continuous nitrogen sweep of teh vapor space in Tanks 48 and 49 to maintain the oxgyen concentration at a level that ensures that vapor deflagration and fires do not occur. Another function of this system is to maintain the concentration below the composite lower flammability limit (LFL). This report documents an analysis of the nitrogen sweep system that includes: a fault tree analysis that evaluates the unavailability of the nitrogen sweep system for Tanks 48 and 49; a recovery analysis applied to the dominant failures identified in the fault tree analysis, and an analysis of a benzene explosion for a Type 3 waste tank. 6 refs., 5 figs., 15 tabs.

27747 (WSRC-RP–89-1328) **Analytical support for a new, low-level radioactive wastewater treatment plant.** Jones, V.D.; Marsh, J.H.; Ingram, L.M.; Melton, W.L.; Magonigal, E.J. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009128. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Savannah River Site (SRS) located in Aiken, SC, is operated by Westinghouse Savannah River Company under contract with the US Department of Energy. The mission of SRS is to manufacture radioisotopes for use in national defense and space exploration. The F/H Effluent Treatment Facility (ETF) is a wastewater treatment plant supporting SRS for low-level radioactive process waste streams. In order to comply with the Federal Resource Conservation and Recovery Act, the facility had to become operational by November 8, 1988. The F/H ETF employs pH adjustment, microfiltration, organic removal, reverse osmosis, evaporation, and ion exchange to remove contaminants prior to discharge to the environment via a state-permitted outfall. Concentrated contaminants removed by these processes are diverted to other facilities for further processing. The ETF is supported by a 24 hr/day facility laboratory for process control and characterization of influent feed, treated effluent water, and concentrated waste. Permit compliance analyses reported to the state of SC are performed by an offsite certified contract laboratory. The support laboratory is efficiently organized to provide: metal analyses by ICP-AES, alpha/beta/gamma activity counting, process ions by Ion Selective Electrode (ISE), oil and grease analyses by IR technique, mercury via cold vapor AA, conductivity, turbidity, and pH. All instrumentation is contained in hoods for radioactive sample handling.

27748 Immobilization of incinerator ash in a concrete matrix. Simpson, R.S. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA)); Charlesworth, D.L. vp. of Proceedings of the international conference on incineration of hazardous, radioactive and mixed wastes. Univ. of California at Irvine, Irvine, CA (USA) (1988). (CONF-880526–: International conference on incineration of hazardous, radioactive, and mixed wastes, San Francisco, CA (USA), 3-6 May 1988).

The ashcrete process will solidify ash generated by the Consolidated Incinerator Facility (CIF) at the Savannah River Plant (SRP). The ashcrete unit produces ashcrete, a stable cement-based wasteform, by remotely adding cement and water and tumbling drums of ash. Ashcrete product homogeneity, temperature rise during setting, and compressive strength were measured and product formulations were developed for several nonradioactive dry ash types. Saturation level and wet and dry ash densities for several ash types have been measured. The authors discuss preliminary mixture formulations for the anticipated ash tested and proof-of-principle test performed using a mockup of the CIF ash system. Mechanical modifications to prepare the unit for use with the CIF and to ensure reliable operation are discussed.

27749 Performance history of the WERF incinerator. Dalton, J.D. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Bohrer, H.A.;

Smolik, G.R. vp. of Proceedings of the international conference on incineration of hazardous, radioactive and mixed wastes. Univ. of California at Irvine, Irvine, CA (USA) (1988). (CONF-880526–: International conference on incineration of hazardous, radioactive, and mixed wastes, San Francisco, CA (USA), 3-6 May 1988).

As society's environmental conscience grows, diverse political economical, and social contentions cloud the issue of proper waste management. However, experience at the Waste Experimental Reduction Facility (WERF) at the Idaho National Engineering Laboratory (INEL) demonstrates clearly that incineration is an effective component in responsible, long-term waste management. Using a simple but safe design, the WERF incinerator has successfully reduced the volume of low-level beta/gamma waste. This paper discusses some of the achievements and problems experienced during operation of the WERF incinerator.

27750 **Demonstration of a steam jet scrubber off-gas system and the burner efficiency of a mixed incinerator facility.** Holmes, H. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA)); Charlesworth, D.L. vp. of Proceedings of the international conference on incineration of hazardous, radioactive and mixed wastes. Univ. of California at Irvine, Irvine, CA (USA) (1988). (CONF-880526–: International conference on incineration of hazardous, radioactive, and mixed wastes, San Francisco, CA (USA), 3-6 May 1988).

A full-scale incinerator system, the Consolidated Incineration Facility (CIF), is being designed to process solid and liquid low-level radioactive, mixed, and RCRA hazardous waste. This facility will consist of a rotary kiln, secondary combustion chamber (SCC), and a wet of-gas system. A prototype steam jet scrubber wastewater will be immobilized in a cement matrix after assumptions for the CIF. The scrubber wastewater will be immobilized in a cement matrix after the blowdown has been concentrated to a maximum solids concentration in a cross-flow filtration system. A sintered metal inertial filter system has been successfully tested. Burner efficiency was tested in a high intensity vortex burner, which destroyed the hazardous waste streams tested. These tests are detailed by the authors.

27751 **Friction welded closures of waste canisters.** Klein, R.F. (Pacific Northwest Lab., Richland, WA (USA)). pp. 60 of Proceedings of the 1987 Pacific Northwest metals and minerals conference (abstracts): Modern mineral and metal technology. Albany Research Center, Albany, OR (USA) (1987). (CONF-8704166–: Pacific Northwest metals and minerals conference, Portland, OR (USA), 26-28 Apr 1987).

Liquid radioactive waste presently stored in underground tanks is to undergo a vitrifying process which will immobilize it into a solid form. This solid waste will be contained in a stainless steel canister. The canister opening requires a positive-seal weld, the properties and thickness of which must be at least equal to those of the canister material. All studies and tests performed in the work discussed in this paper have the inertia friction welding concept to be highly feasible in this application. This paper describes the decision to investigate the inertia friction welding process, the inertia friction welding process itself, and a proposed equipment design concept. This system would provide a positive, reliable, inspectable, and full-thickness seal weld while utilizing easily maintainable equipment. This high-quality weld can be achieved even in highly contaminated hot cell.

27752 **Lead-iron phosophate glass.** Sales, B.C. (Solid State Division, Oak Ridge National Lab., Oak Ridge, (TN)); Boatner, L.A. pp. 778 of Radioactive waste forms for the future. Lutze, W.; Ewing, R.C. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1988). DOE Contract AC05-84OR21400.

The lead-iron phosphate nuclear waste glasses (LIPNWG) are the subject of the present chapter. They were discovered in 1984 while the authors were attempting to find a sintering aid for certain types of crystalline monazite ceramic high-level nuclear waste forms. In the present chapter, the term waste glass is synonymous with nuclear waste glass (NWG), and the acronym LIP is often used for lead-iron phosphate. Lead-iron phosphate glasses, like many of the previously studied phosphate glasses, are corrosion resistant in aqueous solutions at temperatures below 100°C, and they can be melted and poured at temperatures that are relatively low in comparison with the processing temperatures required for current silicate glass compositions. Unlike the phosphate glasses investigated previously, however, LIPNWGs do not suffer from alteration due to devitrification during realistic and readily, achievable cooling periods. Additionally, lead-iron phosphate glass melts are not nearly as corrosive as the sodium phosphate melts investigated during the 1960s; and, therefore, they can be melted and processed using crucibles made from a variety of materials.

27753 **Mechanical decontamination of primary reactor piping. Preliminary feasibility study.** Asay, R.H. (Radiological and Chemical Technology, Inc., San Jose, CA (USA)). pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

This work demonstrated the applicability and feasibility of a mechanical decontamination method that not only provides improved decontamination factors over dilute chemical methods, but nearly eliminates the need for special waste handling of decontamination wastes (water only). The method also provides for a clean base metal surface for which a commercially available passivation process can be applied to the component which is to be returned to service in the nuclear system. Application of the method was demonstrated to be very rapid and straightforward. Tooling and related equipment are readily available to the nuclear industry at minimal costs. The tools used for the application do not become highly contaminated to the point where special handling is required.

27754 **Population and worker exposure from high-level waste production and management.** Faust, L.G. (Pacific Northwest Lab., Richland, WA (USA)); Stephan, J.G.; Selby, J.M. pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

This paper compares the estimates of radiological exposures for nuclear industry workers with those for offsite populations. Occupational exposures, which are routine and chronic, are measurable because of the controlled conditions and availability of proper equipment. By comparison, doses to the offsite public result from very diluted concentrations of radionuclides in the environment resulting from restricted releases of radioactive materials or (under unusual circumstances) the transportation of wastes. Thus, estimates of doses to the offsite public must take into account the release and transport of radiation through the environment, and therefore must be calculated rather than measured. Data are provided showing that production and waste-management activities at those Department of Energy (DOE) sites have resulted in reported occupational doses of up to 500 mrem/man-year while offsite, population doses have averaged up to 0.05 mrem/person, with a maximum individual annual dose of up to 0.7 mrem. By comparison, a commercial jet flight of five hours may result in a dose of about 2.5 mrem, depending on altitude and geographic latitude.

27755 **Review of low-level waste management.** Tang, Y.S. (Univ. of Pittsburgh, PA (USA)). pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

Low-level radioactive waste (LLRW) are currently disposed by land burial at only three commercial sites. Disposal has become a problem of increasing significance to waste generators. Faced with such a situation in conjunction with rapidly rising costs, most utilities are turning to advanced volume-reduction treatment systems. The management of LLRW includes the steps starting from segregation, treatment, conditioning, packaging, shipment and eventually to disposal. Assessment of treatment technologies was made through the recently reported survey by ORNL among utilities. Recent operational experience of volume reduction systems also

indicates that a viable management system is achievable. Experience acquired at the commercial LLRW disposal sites provided a basis for understanding the problems associated with such site, and solutions were shown to be available. Research and development programs carried out by the Commission of the European Communities are also discussed.

27756 **Reduction of low-level radioactive waste at the Oak Ridge Y-12 plant.** Butcher, B.T. (Martin Marietta Energy Systems, Inc., Oak Ridge (USA)); Simon, K.F. pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104--: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

In an effort to reduce low-level radioactive waste volumes, the Department of Energy, Oak Ridge Y-12 Plant is employing supplemental radiation monitoring of waste streams and has initiated a pilot program for identifying sources of contamination and segregating waste in the work place. The major low-level radioactive waste stream targeted for waste minimization efforts is combustible solid waste in bulk quantities. Current attempts at segregation involve concentrating contamination into a smaller volume, thereby reducing controls on disposal of the larger uncontaminated portion.

0530 Environmental Aspects

Refer also to citation(s) 27658, 27678, 27679, 27681, 27695, 27702, 27715, 27716, 27726, 27727, 27728, 27729, 27731, 27740, 27742, 27745, 27749, 27750, 27752, 27767, 28143

27757 (CEGB-RD/L-3486/R89) **On the marine fauna of the Anglesey coast adjacent to Wylfa power station.** Bamber, R.N. Central Electricity Research Labs., Leatherhead (UK). Apr 1989. 25p. Order Number DE90624691. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The findings of recent surveys of the marine fauna in the vicinity of Wylfa Power Station are collated and discussed in the context of previous studies on the biota of this coast. The surveys included a study of the mussel populations of the north Anglesey coast, general surveys of rocky shore and beach habitats and of Cemlyn Beach and Lagoon and a detailed quantification of cliff-dwelling species from which those influenced by the cooling water have been identified. (author).

27758 (CONF-9002111-1) **Development of a consolidated environmental data base.** Voorhees, L.D. Oak Ridge National Lab., TN (USA). [1990]. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. From Proceedings, data analysis and interpretation for environmental surveillance; Lexington, KY (USA); 5-7 Feb 1990. Order Number DE90009419. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A great deal of time, resources, and money has been and continues to be spent on designing and implementing a variety of environmental monitoring programs at US Department of Energy (DOE) facilities. A Federal Facility Agreement between DOE, the US Environmental Protection Agency, and the Tennessee Department of Health and Environment calls for the development of a consolidated environmental data base for the DOE Oak Ridge Reservation (ORR) facilities operated by Martin Marietta Energy Systems, Inc. The objectives of establishing the Energy Systems Environmental Data Base are to ensure long-term retention and accessibility of data collected at all facilities, support the development of a common format for reporting environmental monitoring data, and facilitate the sharing of data in support of environmental compliance and restoration assessments. To achieve these objectives, a Data Management Steering Committee will be established. The committee will define the data management needs; identify the types and sources of data to be maintained; characterize the hardware and software capabilities at each facility; develop a standard data base scheme; and set standards for the contents, quality, and documentation of the data sets. These steps will culminate in the preparation of a Data Management Plan to be implemented at each facility. Major areas of concern include software standards, communications, data collection procedures, data entry, variable naming conventions, chemical nomenclature, units of measurement, levels of precision, date and time formats, spatial coordinates, missing values, quality assurance elements, security, and data exchange formats and procedures. 4 refs.

27759 (JAERI-M-89-192) **Progress report on safety research of high-level waste management for the period April 1988 to March 1989.** Nakamura, Haruto (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Muraoka, Susumu (eds.). Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 78p. Order Number DE90777740. Available from NTIS (US Sales Only), PC A05/MF A01.

Researches on high-level waste management at the High Level Waste Management Laboratory and the Waste Safety Testing Facility Operation Division of the Japan Atomic Energy Research Institute in the fiscal year of 1988 are reviewed. The topics are following studies on the long-term chemical behaviors of long-lived nuclides in geosphere. (1) Mineralogical researches on the alteration layer of glass exposed to water were carried out by laboratory experiments and investigation of natural glass. Leaching experiments of Pu and Np were also conducted. (2) The spectroscopic methods are applied to study the long-term reaction path modeling of radionuclide fixation using natural materials. (author).

27760 (ORNL/TM-11431) **Geologic characterization of the Paducah Gaseous Diffusion Plant and surrounding area determined from geophysical logs.** Dreier, R.B. (Oak Ridge National Lab., TN (USA)); Kennard, R.O.; Selfridge, R.J. Oak Ridge National Lab., TN (USA). Feb 1990. 108p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010212. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Environmental Sciences Division Publication No. 3428.

The Paducah Gaseous Diffusion Plant (PGDP) discovered in August 1988 that several private wells, generally north of the plant, were contaminated with trichloroethylene and/or ^{99}Tc. Presumably, PGDP is the source of both contaminants, and the most likely pathway for contaminant transport is within a regional aquifer that underlies the site. However, it is not possible to characterize potential flow paths and remediate the contamination until the geologic setting of the site is determined and additional well construction information is obtained. It was decided to conduct a geophysical logging project on- and off-site to determine the stratigraphic characteristics of the region. Four types of geophysical logs were obtained from each well: caliper, natural gamma ray, thermal neutron, and gamma-gamma density. This report presents the results of the geophysical logging. 12 refs., 13 figs., 4 tabs.

27761 (PNL-7271) **A survey for elevated levels of uranium north of the 300 Area on the Hanford Site.** Poston, T.M. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 31p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90010007. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A comprehensive survey of soil uranium (U) concentrations in a study area due north of the 300 Area on the Hanford site has been conducted by Pacific Northwest Laboratory (PNL). The objective of the study was to determine the spatial distribution of uranium in the study area and to ascertain if background levels of uranium have been increased by Hanford operations. Based on the spatial distribution of ^{238}U, the highest concentrations of uranium are located in the southern portion of the study area adjacent to the 300 Area complex and in the most eastern zone of the study site bordering the Columbia River. Uranium-236, an isotopic marker of fuel processing activities in the 300 Area, was detected in all eight samples selected from the study. A significant and positive regression was demonstrated between the ratios of ^{236}U/^{238}U in these eight samples and proximity to the 300 Area. 9 refs., 18 figs., 9 tabs.

27762 **Population exposures from UF_6 conversion and fuel fabrication facilities.** Shum, E.Y. (Nuclear Regulatory Commission, Washington, DC (USA)). pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New

York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

There are presently two commercial uranium hexafluoride conversion and six fuel fabrication facilities in the US. The routine operations of these facilities result in the release of small quantities of radioactivity to the environment. The radioactive releases from these facilities are in compliance with the Environmental Protection Agency environmental radiation standards for nuclear fuel cycle facilities. The population doses within a 50-mile radius of these facilities are less than 1% of the collective doses received from background radiation. It is concluded that the publics radiation exposures arising from these facilities are small.

27763 Potential exposures from uranium enrichment. Kennedy, W.E. Jr. (Pacific Northwest Lab., Richland, WA (USA)). pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). DOE Contract AC06-76RL01830. (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

Public radiation doses resulting from gaseous diffusion enrichment facility effluents can be assessed by considering the potential environmental exposure pathways. These exposure pathways result from releases to both air and water, and rely on model evaluations to predict environmental transport. For most airborne releases, inhalation is the primary exposure pathway. Secondary pathways, including external exposure during plume passage, ingestion of uranium deposited on or contained in vegetation, and external exposure to uranium deposited /on land surfaces also contribute. For liquid effluents, the primary exposure pathway is ingestion of aquatic biota and ingestion of irrigated begetation. This paper contains a review of the important considerations for conducting collective dose assessments for gaseous diffusion enrichment facility operations, including discussions of the dosimetric considerations for uranium, and a summary of estimated collective doses resulting from gaseous diffusion enrichment in the United States.

27764 Ground water monitoring strategies at the Weldon Spring Site, Weldon Spring, Missouri. Meyer, K.A. Jr. (Jacobs Engineering Group, St. Charles, MO (USA)). pp. 448 of Proceedings of the second national outdoor action conference on aquifer restoration, ground water monitoring and geophysical methods. Volume III. National Water Well Association, Dublin, OH (US) (1988). (CONF-8805312–: 2. national outdoor action conference on aquifer restoration, ground water monitoring and geophysical methods, Las Vegas, NV (USA), 23-26 May 1988).

This paper presents ground water monitoring strategies at the Weldon Spring Site in east-central Missouri. The Weldon Spring Site is a former ordnance works and uranium processing facility. In 1987, elevated levels of inorganic anions and nitroaromatics were detected in ground water beneath the site. Studies are currently underway to characterize the hydrogeologic regime and to define ground water contamination. The complex hydrogeology at the Weldon Spring Site requires innovative monitoring strategies. Combinations of fracture and conduit flow exist in the limestone bedrock. Perched zones are also present near surface impoundments. Losing streams and springs surround the site. Solving this complex combination of hydrogeologic conditions is especially challenging.

0540 Health and Safety

Refer also to citation(s) 27679, 27681, 27686, 27704, 27743, 27762, 27763, 28056, 28066, 28080, 28081, 29107, 29171

27765 (AEEW-R–2520) **Decontamination by foams: A promising treatment for the removal of radioactive dust from gas streams.** Mitchell, J.P. UKAEA Atomic Energy Establishment, Winfrith (UK). Chemistry Div. Jun 1989. 30p. Order Number DE90624701. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Foams provide a promising method for the treatment of gas streams containing radioactive aerosol particles. A review of the literature has been undertaken to define and assess the mechanics of aerosol behaviour in contact with foams. Applications are also examined in which foams have been used to treat aerosols. Key issues are identified which require further study. In particular, the efficiency of sub-micron particle removal can be determined using recently developed analysers and the use of the process gas to generate the foam could have a major impact on the design of commercial units. (author).

27766 (DOE/DP/00150–T1) **The nuclear weapons complex: Management for health, safety, and the environment.** National Research Council, Washington, DC (USA). Committee to Provide Interim Oversight of the DOE Nuclear Weapons Complex. 1989. 156p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC01-88DP00150. Order Number DE90009479. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The Department of Energy (DOE) operates 17 major facilities to develop and produce nuclear weapons. The facilities, which together are termed the "weapons complex," include laboratores that design and test the weapons and components; materials for use in weapons; and weapons production facilities that either produce various components or assemble them into completed weapons, or both. This report, which was requested of the National Research Council by DOE at the direction of Congress, sets out an assessment of various management, environmental, health, and safety issues melting to the operation of the complex. An examination of the weapons complex is an immense undertaking. The facilities are located throughout the United States, and each of the major facilities is a huge and sophisticated operation. The total budget of the complex for FY 1990 amounts to some $10 billion and involves a staff of some 80,000 people working for the Department and its contractors. The Department confronts a variety of problems in connection with its stewardship of the complex. Many of the facilities are old, and maintenance over the years has been inadequate. There is a legacy of environmental contamination that must be addressed. Moreover, DOE must be prepared to operate under close public scrutiny and in compliance with environmental and safety standards that have become increasingly stringent over time. 42 refs., 8 figs., 4 tabs.

27767 (DOE/EH–0144) **Compliance assessment of the Portsmouth Gaseous Diffusion Plant.** USDOE Assistant Secretary for Environment, Safety and Health, Washington, DC (USA). Apr 1990. 352p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90008195. Available from NTIS, PC A16/MF A01 - OSTI; GPO Dep.

This document contains the findings identified during the Tiger Team assessment of the Department of Energy's (DOE) Portsmouth Gaseous Diffusion Plant in Piketon, Ohio, conducted by the Department's Office of Environment, Safety and Health between October 23 and November 17, 1989. The scope of the assessment of the Portsmouth Complex was comprehensive, covering all areas of the environment, safety and health (ES&H) activities, including compliance with Federal, state and local regulations, requirements, permits, agreements, orders and consent decrees, and DOE ES&H Orders. At the conclusion of the onsite assessment activities, the preliminary findings were submitted to the Office of Nuclear Energy, the Oak Ridge Operations Office, the Portsmouth Enrichment Office, and regulatory agencies for review and comment on technical accuracy. Final modifications and any other appropriate changes are incorporated herein. 73 refs., 3 figs., 12 tabs.

27768 (EGG-CPE–8880) **Transformer site decontamination technology assessment report.** Kearney, K.A. EG and G Idaho, Inc., Idaho Falls, ID (USA). Dec 1989. 68p. Sponsored by U.S. Department of Defense; U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009630. Available from NTIS, PC A04/MF A01 - OSTI.

The Naval Civil Engineering Laboratory contracted with the Idaho National Engineering Laboratory to do a Polychlorinated Biphenyl (PCB) transformer spill cleanup methodology assessment at the Naval Air Station North Island (NASNI). The Public Works Center (PWC) at NASNI has implemented a program to have all PCB transformers retrofilled or replaced by 1992 to reduce their legal liability under the Toxic Substance Control Act. PWC also wanted to reduce their liability by ensuring that the cleanup method employed

sufficiently decontaminated spill surfaces as outlined in the federal regulations. 24 refs., 3 figs.

27769 (FMPC–2114-Rev.2) **Environment, safety, health and waste management plan: Revision 2.** Westinghouse Materials Co. of Ohio, Cincinnati, OH (USA). Feed Materials Production Center. Spr 1989. 310p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-86OR21600. Order Number DE90009917. Available from NTIS, PC A14/MF A01 - OSTI; GPO Dep.

The Feed Materials Production Center (FMPC) was built in the early 1950's to establish an in-house integrated production complex for processing uranium feed materials to finished uranium metal products for use in DOE Defense Programs. The site mission is now undergoing a transition from production to environmental restoration, with continued emphasis on employee safety and community protection. This comprehensive management plan integrates the various environment, safety and health improvements and waste management activities to address issues and concerns through FY-1995. Projects identified in this Plan are prioritized according to criteria that considers: public or employee health and safety; environmental impact; public or government property damage; regulatory compliance; and economic factors. 43 figs., 38 tabs.

27770 (NAC-AR–86-01, pp. 163-164) **The research group: Radiation safety and regulatory aspects.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986*. Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The NAC has obtained licences for beam production to its full capacity in SPC1 as well as for internal beams up to 200 MeV, 1 μA in the SSC. Application has also been made for the production of external beams with the SSC. All initially planned radiation protection systems in and around the accelerators have been installed and checked as far as possible. These include the area radiation monitoring system and equipment for evacuation of vaults and maintaining access control. Air monitoring systems in the exhausts from the radioisotope production areas and accelerator vaults have been designed. A system for the management of radioactive waste has also been planned. Routine tasks of the Radiation Safety Division such as training of radiation workers, personnel dosimetry, arrangement of medical examinations and maintenance of safety around the accelerator vaults were continued. Personnel doses during the past year were negligible because activation of cyclotron components is still very low.

27771 (NKS–1989-9) **Plan for Nordic nuclear safety program 1990-1993.** NU-serien, 1989:5. Nordisk Kontaktorgan for Atomenergispoergsmaal, Risoe (Denmark). May 1989. vp. (In Swedish, Norwegian, Danish Available from Available on loan from Risoe Library, DK-4000 Roskilde.

A 4yr. Nordic research program on reactor safety is described. The plan includes the subjects of nuclear wastes and nuclear waste disposal, radioecology, reactor safety and safety measures for abnormal radiation situations. The program will contribute to the Nordic countries' competance in this area so that they will better be able to evaluate safety measures in nuclear plants in other countries and to take remedial measures in cases where radiation leaks spread over their national boundaries. Knowledge gained will also prove significantly useful in relation to international agreements on information dissemination and assistance in the case of reactor accidents. (AB).

27772 (OEFZS–4517) **Results of a ring comparison analysis for gamma spectrometers in Austria: Air-filter A-1989.** Steger, F.; Lovranich, E.; Leitner, A. Oesterreichisches Forschungszentrum Seibersdorf GmbH (Austria). Inst. fuer Strahlenschutz. Nov 1989. 47p. (In German). (ST–174/89). Order Number DE90624703. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

For gammaspectrometric measuring devices in Austria, which are named by the Austrian Radiation Protection Commission to determine radioactivity after radiation accidents and reactor disasters, an intercomparison run with airfilters was organized. Results are presented and data such as comparision, reproducibility, absolute accuracy and others were calculated. 6 refs., 3 tabs. (Authors).

27773 **Population exposure from the nuclear fuel cycle: Review and future direction.** Richmond, C.R. (Oak Ridge National Lab., TN (USA)). pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

The legacy of radiation exposures confronting man arises from two historical sources of energy, the sun and radioactive decay. Contemporary man continues to be dependent on these two energy sources, which include the nuclear fuel cycle. Radiation exposures from all energy sources should be examined, with particular emphasis on the nuclear fuel cycle, including incidents such as Chernobyl and Three Mile Island. In addition to risk estimation, concepts such as de minimis, life shortening as a measure of risk, and competing risks as projected into the future must be considered in placing radiation exposures in perspective. The utility of these concepts is in characterizing population exposures for decision makers in a manner that the public may judge acceptable. All these viewpoints are essential in the evaluation of population exposure from the nuclear fuel cycle.

27774 **Risk-based radiation standards for exposure control: Approaches to radiation protection.** Bond, V.P. (Brookhaven National Lab., Upton, NY (USA)). pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

The concept of risk is defined and the elements of a risk-based system for radiation protection are presented. ICRP 26 and especially the recent NCRP 91 report are used to illustrate the development and current status of risk-based systems for exposure control. Reasons for, and the significance of the more restrictive exposure limits in NCRP 91 are given. A discussion of the changes is followed by a discussion of the conceptual appropriateness of some aspects of present approaches to setting radiation protection limits.

27775 **ALARA and de minimis concepts in regulation of personnel exposure.** Baum, J.W. (Brookhaven National Lab., Upton, NY (USA)). pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). DOE Contract AC02-76CH00016. (CONF-8709104–: ANS/ORNL topical conference on popuiation exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

It is suggested that the ALARA process should not be limited by a de minimis level on either collective or individual dose. Instead it should be limited or defined by: (a) an acceptable discount-rate on future costs and effects, and (b) a monetary value for detriment (e.g. $10,000 to $20,000/person-Sv; $100 to $200/person-rem) to be used in cost-effectiveness or cost benefit calculations at dose levels well below the regulatory limits. This approach would provide the desired benefit of simplifying the decision process and thereby making it more cost effective and would avoid the inconsistencies of limits on only one of the four parameters of importance in the optimization process. These are: average individual effective dose equivalent rate, number of individuals to be included in the summation, years of exposure, and costs, which include costs of analysis to reduce the exposure. This is not to claim that individual doses of 10 to 100 μsv/yr (1 to 10 mrem/yr) are not trivial, but rather to emphasize that these doses to an individual may not be considered trivial by society when given to a very large population, especially if they could easily be avoided. The latter factor, in particular, is often overlooked in discussions of the de minimis concept.

27776 **Overview of the occupational exposure to the power reactor workforce.** Driscoll, S.L. (Institute of Nuclear Power Operations, Atlanta, GA (USA)). pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New

York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

The Institute of Nuclear Power Operations (INPO) has been evaluating US nuclear utility efforts at reducing occupational exposures. Information has been collected from their own plant evaluators, the INPO Plant Performance Indicator Program, data provided by foreign countries, as well as the NRC annual exposure reports. A review of this information demonstrates a number of factors contributing to relatively high collective exposures at certain plants. Some PWR and BWR plants consistently (i.e., over a 5 year period), have high collective exposures and very large numbers of personnel exposed when compared to other plants of the same type and size. Additionally, a review of individual station performance has identified three factors that seem to control collective exposures: work load, productivity, and out of core radiation levels. These factors will be discussed, along with an overview of past industry performance and initiatives for maintaining the current trend of reducing collective exposures.

27777 **A comparison of European and American practices and procedures.** Britz, W.L. pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

A comparison of European and American practices and exposures indicates that greater emphasis has been placed on the reduction of individual and collective personnel radiation exposures in the European nuclear reactors. Several factors which contribute to their lower radiation doses are: (1) a strong management commitment to achieving low exposure; (2) plant design and modifications to reduce exposure; (3) good staffing, training, and work planning; (4) good chemistry control; (5) utilization of innovative technical methods for reducing plant exposures; (6) good regulatory environment. A significant effort has been made to reduce radiological exposures in the US and the past few years indicates good success. These are due to the efforts of Institute of Nuclear Power Operations (INPO) and the nuclear industry, and the culmination of Many Nuclear Regulatory Commission (NRC)-initiated multi-plant actions in the period 1979-83 which resulted in many plant modifications and high exposures. Even though the US exposures have been reduced considerably, there is still opportunity for improvement. More consideration needs to be given to materials use (reduction of corrosion activation products), management, chemistry operations, and incorporating a good radiological protection attitude and more responsibility in all nuclear plant personnel. For the future, we as a country need to define our collective exposure goals for our next generation of nuclear reactors so that they can now be incorporated into the design. Other countries have established these goals, but the US has not. These goals should bear a relationship to average individual occupational exposures so that a logical and meaningful relationship between the 2 is developed into future design and operations. The goal should be reasonable from a health effect viewpoint so that monies are not expended without justification.

27778 **Routine exposure from fast reactor fuel reprocessing operations.** Barnes, D.S. (United Kingdom Atomic Energy Authority, Culcheth (England)); Brown, M.L.; Meggitt, G.C.; Nicholson, S. pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

This paper describes the methodology used to evaluate individual doses from routine radioactive effluent discharges from the proposed European Demonstration Reprocessing Plant (EDRP). The facility would service a series of 3 or 4 fast reactors, and have an annual throughput of 60-80 tons. Data obtained from currently operating fuel reprocessing plants and from development programs have been used to estimate discharges from EDRP. The environmental impact of both aerial and liquid effluents is small being only 5% and 2% respectively of the 1 mSv ICRP dose limit, and also well below that from natural radiation exposure.

27779 **Inhalation hazards to underground miners.** Beckman, R.T. (Safety and Health Technology Center, Denver, CO (USA)). pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

Massive radon-daughter exposures to miners have caused lung cancer for centuries. Exposures in US uranium mines have been regulated for 15 years and, during this time, relatively few miners have been exposed to over 4 WLM year. Present trends are toward lower annual exposures and shorter working lives. The net effect has been to hold cumulative lifetime exposures well below the level at which statistically significant excess risk has been shown.

27780 **Potential consequences of yellowcake inhalation.** Eidson, A.F. (Lovelace Biomedical and Environmental Research Institute, Inc., Albuquerque, NM (USA)); Damon, E.G.; Hahn, F.F.; Pickrell, J.A.; Muggenburg, B.A. pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). DOE Contract AC04-76EV01013. (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

The uranium ore milling process includes dusty operations and workers can be exposed to aerosols of highly concentrated uranium. Measurements made during uranium milling operations were used to predict that, if a worker was not wearing respiratory protection, 0.14-50 μg U/min might be deposited in the respiratory tract, predominantly in the nesopharyngeal compartment. Yellowcake was shown by infrared and solubility measurements to be a highly variable mixture of ammonium diuranate and U_3O_8. Biokinetic studies of inhaled yellowcake in beagle dogs showed that the more soluble fraction caused kidney damage. After inhalation of 0.5 mg U/kg body wt of soluble uranium, kidney concentration was 0.3 to 3.5 μg U/g kidney within 4-8 days; and was accompanied by kidney damage. Kidney damage was neither severe nor widespread, and was repaired witnin 64 days after exposure. The damage seen is due to heavy metal nephrotoxicity of uranium, and not to radiation damage.

27781 **Population exposure from radon associated with uranium milling.** Nelson, C.B. (Environmental Protection Agency, Washington, DC (USA)). pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

On September 24, 1986, the Environmental Protection Agency (EPA) published a rule requiring work practices to control radon emissions from licensed uranium mill tailings sites. The total annual release from currently licensed sites with tailings piles was estimated to be about 130 kCi. If these piles were allowed to completely dry, this value would rise to about 240 kCi. The regional and national annual collective exposures from current releases were calculated to be 2,000 person-WLM and 3,500 person-WLM respectively. After 1992, licensed mills must use phased or continuous techniques for all tailings management unless they are granted exceptions or extensions. Radon exposures to the US population from licensed uranium mills should drop substantially as the result of this change in work practice.

0550 Safeguards, Inspection, and Accountability

27782 (CONF-900607–3) **Computerization of the safeguards analysis decision process.** Ehinger, M.H. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From Advances in human factors research on man-computer interactions: nuclear and

beyond; Nashville, TN (USA); 10-15 Jun 1990. Order Number DE90007052. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Safeguards regulations are evolving to meet new demands for timeliness and sensitivity in detecting the loss or unauthorized use of sensitive nuclear materials. The opportunities to meet new rules, particularly in bulk processing plants, involve developing techniques which use modern, computerized process control and information systems. Using these computerized systems in the safeguards analysis involves all the challenges of the man-machine interface experienced in the typical process control application and adds new dimensions to accuracy requirements, data analysis, and alarm resolution in the regulatory environment. 4 refs., 1 fig.

27783 (KFK–4157) **Evaluation of IDA-80 data by the DoD method.** Beyrich, W.; Golly, W. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Datenverarbeitung in der Technik; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Wiederaufarbeitung und Abfallbehandlung. Dec 1989. 80p. (EUR–10533-EN;PWA–64/89). Order Number DE90780227. Available from NTIS (US Sales Only), PC A05/MF A01.

The measurement data of 28 interlaboratory analysis performed under the IDA-80 programme are evaluated by the DoD (Distribution of Differences) method with respect to the RSDs of the interlaboratory spreads and the within-laboratory uncertainty components. The resulting estimates are compared to those obtained by variance analysis after application of outlier criteria in the official IDA-80 evaluation. Deviations found in case of the within-laboratory uncertainty components ('run' component of the IDA-80 evaluation) are discussed. (orig./HP).

27784 (NBL–322) **New Brunswick Laboratory progress report for the period October 1988–September 1989.** USDOE New Brunswick Lab., Argonne, IL (USA). Apr 1990. 56p. Sponsored by U.S. DOE Defense Programs. Order Number DE90009545. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The mission of the New Brunswick Laboratory (NBL) of the US Department of Energy (DOE) is to provide and maintain a nuclear material measurements and standards laboratory as a technical response to DOE's statutory responsibility to assure the safeguarding of nuclear materials. This report summarizes the mission-fulfilling activities of NBL for the period October 1988 through September 1989.

27785 (ORNL/TM–11497) **Source inventory limits.** Kerr, G.D.; Eckerman, K.F. Oak Ridge National Lab., TN (USA). Mar 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010211. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A new set of values has been developed for exempting sealed sources of radioactive materials from inventory. The criteria for exemption are (a) the annual occupational dose from external radiation at 1 m from the source is approximately 10 mrem (100 μSv) or less, and (b) the source activity was approximately equal to the annual limit on intake by inhalation or less than 1000 μCi (4×10^7 Bq). These criteria were selected to correspond to an annual occupational dose of approximately 5 to 50 mrem and a small potential annual risk of approximately 1×10^{-6} to 1×10^{-5} fatal cancers or less. 24 refs., 2 figs., 1 tab.

0560 Legislation and Regulations

Refer also to citation(s) 27981, 27984, 27985, 28066, 28133, 29572

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0701 Physical Isotope Separation

Refer also to citation(s) 28684

0702 Radiation Sources

Refer also to citation(s) 28612, 28802, 28841

27786 (CONF-9003100–3) **Materials for cold neutron sources: Cryogenic and irradiation effects.** Alexander, D.J. Oak Ridge National Lab., TN (USA). [1990]. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International workshop on cold neutron sources; Los Alamos, NM (USA); 5-8 Mar 1990. Order Number DE90009808. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Materials for the construction of cold neutron sources must satisfy a range of demands. The cryogenic temperature and irradiation create a severe environment. Candidate materials are identified and existing cold sources are briefly surveyed to determine which materials may be used. Aluminum- and magnesium-based alloys are the preferred materials. Existing data for the effects of cryogenic temperature and near-ambient irradiation on the mechanical properties of these alloys are briefly reviewed, and the very limited information on the effects of cryogenic irradiation are outlined. Generating mechanical property data under cold source operating conditions is a daunting prospect. It is clear that the cold source material will be degraded by neutron irradiation, and so the cold source must be designed as a brittle vessel. The continued effective operation of many different cold sources at a number of reactors makes it clear that this can be accomplished. 46 refs., 8 figs., 2 tab.

0703 Isotopic Power Supplies

Refer also to citation(s) 27975

0704 Economic, Industrial, and Business Aspects

27787 (N–90-15836) **Report of NASA Lunar Energy Enterprise Case Study Task Force.** Kearney, J.J. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Jul 1989. 176p. (NASA-TM–101652;NAS–1.15:101652). Available from NTIS, PC A09/MF A02.

The Lunar Energy Enterprise Case Study Task Force was asked to determine the economic viability and commercial potential of mining and extracting He-3 from the lunar soil, and transporting the material to Earth for use in a power-generating fusion reactor. Two other space energy projects, the Space Power Station (SPS) and the Lunar Power Station (LPS), were also reviewed because of several interrelated aspects of these projects. The specific findings of the Task Force are presented. Appendices contain related papers generated by individual Task Force Members.

27788 (N–90-15836, pp. 1-37) **Report of the NASA lunar energy enterprise case study task force.** National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Jul 1989. (NASA-TM–101652;NAS–1.15:101652). In *Report of NASA Lunar Energy Enterprise Case Study Task Force*. Available from NTIS, PC A09/MF A02.

The Lunar Energy Enterprise Cast Study Task Force was formed to determine the economic viability and commercial business potential of mining and extracting He-3 from the lunar soil for use in earth-based fusion reactors. In addition, the Solar Power Satellite (SPS) and the Lunar Power Station (LPS) were also evaluated because they involve the use of lunar materials and could provide energy for lunar-based activities. The Task Force considered: (1) the legal and liability aspects of the space energy projects; (2) the long-range terrestrial energy needs and options; (3) the technical maturity of the three space energy projects; and (4) their commercial potential. The use of electricity is expected to increase, but emerging environmental concerns and resource availability suggest changes for the national energy policy. All three options have the potential to provide a nearly inexhaustible, clean source of electricity for the U.S. and worldwide, without major adverse impacts on the Earth's environment. Assumption by industry of the total responsibility for these energy projects is not yet possible. Pursuit of these energy concepts requires the combined efforts of government and industry. The report identifies key steps necessary for the development of these concepts and an evolving industrial role.

27789 (N–90-15836, pp. 40-55) **Analysis of the financial factors governing the profitability of lunar helium-3.** Kulcinski, G.L.; Thompson, H.; Ott, S. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Jul 1989. (NASA-TM–101652;NAS–1.15:101652). In *Report of NASA Lunar Energy Enterprise Case Study Task Force.* Available from NTIS, PC A09/MF A02.

Financial factors influencing the profitability of the mining and utilization of lunar helium-3 are examined. The analysis addressed the following questions: (1) which financial factors have the greatest leverage on the profitability of He-3; (2) over what range can these factors be varied to keep the He-3 option profitable; and (3) what ultimate effect could this energy source have on the price of electricity for U.S. consumers. Two complementary methods of analysis were used in the assessment: rate of return on incremental investment required and reduction revenue requirements (total cost to customers) achieved. Some of the factors addressed include energy demand, power generation costs with and without fusion, profitability for D-He(3) fusion, annual capital and operating costs, launch mass and costs, He-3 price, and government funding. Specific conclusions are made with respect to each of the companies considered: utilities, lunar mining company, and integrated energy company.

27790 (N–90-15836, pp. 150-171) **Importance of helium-3 for the future.** Kulcinski, G.L. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Jul 1989. (NASA-TM–101652;NAS–1.15:101652). In *Report of NASA Lunar Energy Enterprise Case Study Task Force.* Available from NTIS, PC A09/MF A02.

Relevant plasma physics principles of thermonuclear research; the state of plasma physics as it pertains to the D-He(3) cycle; the technological benefits of the D-He(3) fuel cycle; the availability of He(3); and its location, methods of extraction and cost are discussed. A perspective on the rate of progress toward the goal of heating the confined plasma fuel to sufficiently high temperatures at high enough densities and for long enough times to cause substantial fusion of the atoms to take place is given in graphical form. The main technological advantages resulting from the D-He(3) fuel cycle, when compared with the DT cycle, are as follows: (1) increased electrical conversion efficiency; (2) reduced radiation damage to reactors; (3) reduced radioactive waste; (4) an increased level of safety in case of an accident; (5) the lower cost of electricity; and (6) the shorter time to commercialization. An account is given of mining He(3) on the Moon.

08 HYDROGEN

0801 Production

Refer also to citation(s) 27842

27791 **Hydrogen production with coal using a pulverization device.** Paulson, L.E. To Dept. of Energy, Washington, DC. USA Patent 4876080/A/. 24 Oct 1989. Filed date 29 Mar 1988. USA Patent Application 7-175,659. Int. Cl. C01B 1/02. 6p.

This paper describes a method for producing hydrogen from coal is described wherein high temperature steam is brought into contact with coal in a pulverizer or fluid energy mill for effecting a steam-carbon reaction to provide for the generation of gaseous hydrogen. The high temperature steam is utilized to drive the coal particles into violent particle-to-particle contact for comminuting the particulates and thereby increasing the surface area of the coal particles for enhancing the productivity of the hydrogen.

0804 Economic, Industrial, and Business Aspects

27792 (SV-US–1989-34) **Hydrogen, a study of energy efficiencies.** Finnstroem, B. (B. Finnstroem Consulting AB, Stockholm (SE)). Swedish State Power Board, Vaellingby (Sweden). 2 Oct 1989. 49p. (In Swedish). Order Number DE90770783. Available from NTIS (US Sales Only), PC A03/MF A01.

Hydrogen is considered an ideal future energy carrier. Hydrogen is available in umlimited amounts from solar energy and water and hydrogen can be utilized without harmful effects on the environmnet. Hydrogen production can also be environmentally benign, depending on the source of the energy supply (nuclear power, coal, solar energy etc.). The objective of the present report is to describe various processes in the hydrogen system from production, via transport and storage to end- use, emphasizing the energy efficiency. Cost aspects have been considered in few cases and only as comparisons between processes of the same kind. (44 refs.).

09 BIOMASS FUELS

Refer also to citation(s) 28210

27793 (PB–90-159815/XAB) **GRI's (Gas Research Institute's) methane from Biomass and Wastes subprogram. Status report 1982.** Gas Research Inst., Chicago, IL (USA). Dec 1982. 47p. Available from NTIS, PC A03/MF A01.

See also PB–88-173117.

Activities within GRI's Biomass and Wastes Subprogram are discussed. The tactical objectives, goals, accomplishments, research strategies, and contract status are described for the Methane from Biomass and Methane from Wastes project areas.

0907 Resources

27794 (DOE/ER/60879–1) **Testing the scale-dependence of models of resource competition and environmental conditions for forest structure and dynamics: Annual performance report.** Knox, R.G.; Harcombe, P.A. Rice Univ., Houston, TX (USA). [1990]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-89ER60879. Order Number DE90009611. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The goal of the proposed research is to evaluate and integrate two kinds of explanation of forest community structure and dynamic previously developed at different spatial scales. Gradient models describe species distributions and community composition in term of environmental factors, which can usually be associated with conditions for plant growth. Resource competition models explain community dynamics and resulting composition in terms of acquisition of limiting resources. We propose to compare qualitative predications from both approaches at a set of scales where we have detailed data on forest composition and dynamics. We plan to develop and test regional gradient predictions of local patterns, with a set of intensive study sites representing major forest types on the coastal plain and piedmont of the Southeastern United States. We will also compare the results of empirical models of within- and across-site spatial and temporal distribution, i.e. gradient and stage-projection models, with heuristic results from a proposed resource-competition modeling system. 13 ref., 4 fig.

0908 Production

Refer also to citation(s) 29070

27795 (DOE/CE/15270–T13) **Explorations of mechanisms regulating ectomycorrhizal colonization of boron-fertilized pine: Quarterly report, January 1, 1990–March 30, 1990.** Garrett, H.E.; Sword, M.A. Missouri Univ., Columbia, MO (USA). [1990]. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-86CE15270. Order Number DE90009638. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Research continued on the following tasks: effects of ectomycorrhizal inoculation on carbon allocation in pine seedlings; the effects of boron fertilization on the physiology and morphology of short leaf pine seedling root systems; determining the effects of hydroxylation of phenolic compounds on growth; and the evaluation of the effectiveness of phenolase in metabolizing toxic phenolic compounds. Additionally, growth measurements obtained from the initial greenhouse experiment have been presented. 5 refs., 2 tabs. (KD)

27796 (NBES–2067) **Harvesting budworm-damaged stands for fuel: Final report.** Henley, S.G. (York, Sunbury, Charlotte

Wood Products Marketing Board, (Canada)). New Brunswick Energy Secretariat, Fredericton, NB (Canada). Jan 1985. 24p. (CE–02977). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This project was initiated to demonstrate the economics and logistics of harvesting budworm-damaged stands for use as fuel. Dead spruce and balsam fir were to be harvested from small private woodlots in southwestern New Brunswick, using an integrated, full-tree harvesting system to produce wood chip fuel and other forest products. The overall objectives of the study are listed. The harvesting equipment and the selection of sites are discussed. The most efficient methods of finding candidate woodlots was found to be by advertising and word of mouth. Contact was made with 85 woodlot owners, and 45 woodlots were visited and evaluated for their suitability. A further 150 management plans were screened and rejected for various reasons. Only 2 woodlots were initially recognized as potential sites; however, after showing some interest, the owners decided not to participate. The reasons for the rejection of the various woodlots are listed. The fact that a number of owners were against clearcutting, and, in some cases, against any cutting, and that others showed no interest in the study, is attributed to the high percentage of white-collar workers owning woodlots. Other strategies for harvesting dead or scrap wood are suggested. 1 ref., 1 tab.

27797 (NBU/FF–2023) **Small scale wood chip fuel harvesting and processing.** Schneider, M.H.; Short, C.A.; Rickards, E.J.P.S.; Kipping, J.E. New Brunswick Univ., Fredericton, NB (Canada). Faculty of Forestry. Feb 1985. 139p. (CE–02989). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The objectives of the project were to demonstrate and evaluate several small-scale methods of harvesting small (200 mm or less) trees and chipping them for fuel, as well as a method of processing such chips for use in dry chip-fired heating appliances. Nine field trials were conducted using various combinations of equipment. The trials consisted of 2 slash reclamation tests, 2 thinning tests, and 5 clear-cutting tests. The tests were conducted on various sites ranging from 0.2 to 1.8 hectares in area. The trees harvested were small; their average stem diameter was 70 mm. Every site was measured before harvest to predict the amount of biomass present. The amount of material obtained from the sites varied from 50% to 80% of the biomass present. Harvesting consisted of chain-saw felling and delimbing, skidding to roadside using winch, and then chipping into a 30 m^3 portable bin. At the processing facility, the chips were weighed and dumped, reclaimed, metered, screened and delivered to the drying chamber. The chamber has a capacity of 45 m^3 and is fitted with a fan which blows air up through the perforated floor and the 2.4 m depth of chips. Dried chips were moved from the chamber into protected storage with that same vehicle used to reclaim them. Costs to harvest, process and deliver the chips were strongly influenced by labour costs and the basis upon which equipment was acquired. Costs per 20% moisture content tonne ranged from Canadian $39 to Canadian $200, the lowest cost was achieved when chip harvesting was integrated with other silvicultural activities. The report also contains the detailed energy cost of wood chip production, and data on the absolute and relative densities of the harvested woods and of wood chips. 30 refs., 20 figs., 49 tabs.

27798 (STEV-EO–89-16) **Growth maximizing. Intensive cultivating of fast growing deciduous trees. Annual report 1988.** Christersson, L. (Swedish univ. of Agricultural Sciences, Uppsala (SE). Dept. of Ecology and Environmental Research); Ericsson, T. Statens Energiverk, Stockholm (Sweden). Mar 1989. 68p. (In Swedish). Project STEV-196-084. Order Number DE90770767. Available from NTIS (US Sales Only), PC A04/MF A01.

The report presents tests with fast growing tree species on different habitats in Halland(Laanga-Veka), and Ultuna. In the test the maximal yield by optimal supply of nutriants and water was investigated. Certain questions of leakage of water and nutriants from the cultivation were also studied. The test results demonstrate that a very high yield of wood biomass can be attained in a Salix plantation(30-40 tonners wood biomass dry substance per sq. hectare, year). The results also provide information of importance when fertilization procedures in practical cultivation are to be formulated. (26 figs., 10 tabs., 43 refs.).

27799 (STEV-EO–89-17) **Project energy forest cultivation, Swedish university of agricultural sciences: Annual report April 1988 to March 1989.** Ledin, S. (Swedish Univ. of Agricultural Sciences, Uppsala (SE) Dept. of Ecology and Environmental Research). Statens Energiverk, Stockholm (Sweden). Mar 1989. 72p. (In Swedish). Project STEV-116-113. Order Number DE90770768. Available from NTIS (US Sales Only), PC A04/MF A01.

Research has been carried on above all with reference to agricultural land with emphasis on the genus Salix. One aim has been to conduct activities towards fundamental research. At the same time, however, there is the demand to be able to give advice to those who want solutions of problems in energy forest cultivation in practice. The report is divided in four sections: * Biology of the plant. * Ecology of stands. * Cultivation methods with associated field test organisation. * Executive functions. (44 figs., 2 tabs., 32 refs.).

27800 (STEV-EO–89-18) **Big-test south. Energy forest cultivation in the southern Skaane: Final report.** Perman, G. (Sydkraft AB, Malmoe (SE)). Statens Energiverk, Stockholm (Sweden). Jul 1989. 62p. (In Swedish). Project STEV-196-007. Order Number DE90770769. Available from NTIS (US Sales Only), PC A04/MF A01.

In the project, methods and techniques of energy forest cultivation under favourable ground and climate conditions in southern Skaane was tested in practice. The cultivation was carried through on c:a 70 sq. hectare arable land. The test showed that suitable technique is available for establishment of energy forest on good arable soil. At best a yearly growth of 12 tonnes dry matter was obtained. Improved harvesting technique and high yield clones may result in energy forest chips to become competitive. Fauna studies showed that certain species are favoured of the energy forest whereas others decrease in number. The landscape picture should be taken into consideration when locating energy forest cultivation areas. The shelterwood effects may be considerable if the cultivation is established in an open landscape. 15 figs., 2 tabs.

27801 (STEV-TB–89-4) **Techniques and methods of integrated removals of forest fules and industrial wood by final felling.** Statens Energiverk, Stockholm (Sweden). Sep 1988. 187p. (In Swedish). Project STEV-146-277. Order Number DE90770771. Available from NTIS (US Sales Only), PC A09/MF A01.

Commissioned research by Interforest AB, Lidingoe(SE).

The study was directed towards the production of wood fuels from harvesting wastes, branches and tops, in large scale clearcut operations. The primary objective of the the study was to assess the short term possibilities within a 5 year period. The results of the practical field tests and performed economic analyses can be summerized as follows: * All systems worked well. Only the full-tree system is a 'hot system' which requires extra supervision and planning. * All systems produce a considerable volume of wood fuel although less than the reference system. Most wood fuel was produced in the full-tree system for which the quantity of wood fuels is comparable to that of the reference system. The one-grip harvester system gives a higher contribution of wood fuels than the two-grip harvester system. * All systems are economically equal to or better than the reference system. The potential for further development is higher for the studied systems than for the reference system. * All systems are recommended to be further adopted and developed. It can be stated that the potential for increased production of wood fuels is high and that wood wastes from clearcuts constitute an important part of this potential. Presently used methods and machines cna easily be modified to produce also wood fuels. Considering todays fleet of forestry machines in Sweden the greatest potential is with tree-section system. It is also stated in the study that the need for further technical development is moderate. The efforts should be put on organizational changes and improvements of working methods.

0909 Processing

Refer also to citation(s) 27431, 27835, 27837, 28209

27802 (AD-A–216667/6/XAB) **Characterization of biofilm community structure by ribosomal RNA sequences. Annual report, 1 December 1988-30 November 1989.** Stahl, D.A. Illinois Univ., Urbana, IL (USA). 1 Dec 1989. 7p. Available from NTIS, PC A02/MF A01.

The general objectives of this project are to develop molecular techniques, based upon comparative ribosomal RNA sequencing, for the explicit identification and localization of individual microorganisms in natural biofilms. As model systems sulfidogenic and methanogenic fixed-bed bioreactors have been established. Sampling protocols for microscopic and molecular analyses of, and methods for measuring methane production and sulfate reduction within, these bioreactor systems were developed. The use of fluorescent-oligonucleotide probes for visualizing individual sulfate-reducing bacteria within complex biofilms was demonstrated. The polymerase chain reaction as used for the selective amplification of 16S rRNAs from defined physiological assemblages of organisms (methanogens and sulfate-reducing bacteria). The cloning and sequencing of these amplified products has provided an outline of the microbial diversity within the sulfidogenic and methanogenic bioreactors. Comparative sequencing of additional strains of marine and freshwater caulobacters has been completed in association with ONR investigator John Smit. The use of flow cytometry to enumerate a target organism, in a defined mixture of cells, using a genus-specific fluorescent probe was demonstrated.

27803 (KVL-JI-MEDD–61) **Gas scrubbers for heat exchanging and ammonia absorption.** Berthelsen, L. Kongelige Veterinaer- og Landbohoejskole, Tastrup (Denmark). Jordbrugsteknisk Inst. May 1989. 88p. (In Danish). Order Number DE90770685. Available from NTIS (US Sales Only), PC A05/MF A01.

Biomass conversion plants utilizing heat produced by anaerobic digestion need heat exchangers in order that this heat can be used. It is suggested that a double gas scrubber could perform this function as it uses the waste gases from the plant and thus contributes to energy conservation. A treble scrubber is also described in detail, and a computer program for dimensioning of the latter is presented. Ammonia is also emitted from biomass conversion plants, and it is claimed that it could be dissolved, and reclaimed, in the water used in the gas scrubbers. This process is highly improved by adding sulphuric acid to the water used in the scrubbing process. A series of two towers, in which the first is designed as a heat exchanger and the other for ammonia absorption, can also be implemented. These systems are described in detail and illustrated by graphs, diagrams and mathematical calculations. (AB) 33 refs.

27804 (PJM–CE02952, pp. 48-53, Paper 8) **Case study: MacMillan Bloedel Limited Powell River division hog fuel system.** Jones, G. (MacMillan Bloedel, Powell River, AB (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

In 1980 MacMillan Bloedel installed a rotary hog drying system to provide 50% moisture hog fuel for a boiler system which provides process steam to its Powell River mill. This mill has a production capacity of 2200 tons of newsprint and groundwood specialty paper, 200 tons of market pulp and 200,000 board feet of rough sawn lumber annually. Steam is provided to two mills a half mile apart. The drying system uses flue gas from the boilers as a heat source. Wet fuel feed is controlled automatically by the dryer outlet temperature which is set at 200°F yielding product of moisture 45% to 50%. Benefits from the dryer system are as follows: boiler operation is much more stable; excess air requirements for the boiler are substantially reduced; all but the largest load swings can now be handled by hog fuels whereas oil firing was previously required; particulate emissions now comply with permit levels; and load maintenance has been reduced.

27805 (PJM–CE02952, pp. 42-47, Paper 7) **Case study: British Columbia Forest Products Ltd. hog fuel drying system.** Gray, D.H. (B.C. Forest Products, Crafton, BC (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

B.C. Forest Products has installed a Bahco Cascade hog drying system to provide 50% moisture hog fuel for a boiler. Use of this system was expected to increase steam generation of the boiler from 320,000 pounds/h to 400,000 pounds/h and eliminate the use of oil burners to stabilize the boiler furnace. A field test in Sweden of the system using West Coast hog fuels was successful. The Bahco system is based on a pair of dryers each rated at twelve bone dry tonnes per hour of hog fuel. Flue gas from the existing boiler provides the heat for drying. The fuel gas is blown into the system by fans and the fog fuel is held in suspension for drying by the velocity of the flue gas. A deflector at the top of the dryer deflects large particles back into the dryer for longer drying time. A multi-cyclone gas cleaning system has been installed after the dryer to remove fine dust and ash. The system provides three forms of hog fuel; one 38% - 40% moisture, one 60% moisture, and the product of the cyclone cleaner which is 15% to 20% moisture. These streams are reblended to a fairly homogeneous product on a rotary screw conveyor. The equipment cost a total of $8,500,000. Savings in 1983 were $3,700,000.

27806 (PJM–CE02952, pp. 133-138, Paper 24) **The next generation of wood waste fired boilers.** Altmann, A.F. (Combustion Engineering-Superheater Ltd., Ottawa, ON (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

Wood fuel for boilers has become important as a primary fuel due to technological developments in steam generators and to the rising cost of fossil fuels. Fuel preparation is a vital part of the efficiency of the boiler operation. Moisture content and size distribution are the most important fuel criteria. This paper discusses drying systems which can be installed between a mechanical moisture press and the furnace. Flash drying accomplished by pulverizing the fuel in a hot transport medium is the optimal method for moisture reduction. With the use of an impact mill and classifier the particle size can be controlled. This system has the advantage of low retention time and product can be fired directly into the furnace. In a split-firing arrangement fuel is predried by the flue gas from the boiler to an average moisture of 40% to 50%. The dried fuel is screened to a fine powder and fired tangentially into the furnance. The fine particle size insures complete burnout. About one quarter of the total furnace gas is required for drying. 7 figs.

27807 (SLU-IMB–40) **The biogas process in the Nordic countries. Research and Application.** Svensson, Bo (ed.). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. 206p. (In Swedish, English, Norwegia (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). Order Number DE90770812. Available from NTIS (US Sales Only), PC A10/MF A01.

Research, development and operation of anaerobic digestion plants in the Nordic countries was reviewed at the seminar. Most projects were related to agricultural wastes, but existing and planned fermentation plants in industry were also discussed.

27808 (SLU-IMB–40, pp. 20-25) **Degradation of cellulose to methane by defined mixed cultures.** Temmes, A. (Univ. of Helsinki (FI). Dept. of Microbiology); Mettaelae, A.; Nitisinprasert, S. Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish, English, Norwegia (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.*

Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

Bacteria that take part in the cellulose degradation in anaerobic waste treatment processes, were isolated and cocultured in different combinations. In general cellulose degradation was more efficient in cocultures than in pure cultures. The effects varied in different cellulolytic bacteria. The methanogenic bacterium used was shown to fix molecular nitrogen and cellulose degradation, and cellulose degradation was shown to proceed even in nitrogen free medium.

27809 (SLU-IMB–40, pp. 10-19) **The microbiology behind the biogas process, stressing the regulating role of the hydrogen partial pressure.** Ahring, B. (Danmarks Tekniske Hoejskole, Lyngby (DK). Inst. for Bioteknologi); Westermann, P. Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Danish). (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

Anaerobic degradation of organic matter involves a complex mixture of bacteria - each with a specific role in the over-all degradation process. Three major metabolic groups of bacteria are involved: The hydrolytic and fermentative bacteria, which convert complex biopolymers, sugars, amino acids, fatty acids and so on to acetate, hydrogen and carbon dioxide on the one hand, and a mixture of alcohols, fatty acids, succinate, and lactate on the other. The latter substrates have to be converted to acetate, hydrogen, and carbon dioxide by the hydrogen-producing acetogenic bacteria, which depend for thermodynamic reasons on efficient removal of their fermentation product. The third group, the methanogenic bacteria, convert acetate, hydrogen, and carbon dioxide as well as the less important one carbon compounds methanol, methylamine, and formate to methane and carbon dioxide. The key regulator of anaerobic fermantations is hydrogen effectuated through interspecies hydrogen transfer. The special feature of this process is that hydrogen-using organisms can create conditions for obligate hydrogen-producing organisms to perform catabolic oxidations which would not have been energy-yielding in the absence of hydrogen removal. The last decade has brought some significant steps forward in our understanding of the anaerobic fermentation process. However, the influence of the ability of micro-organisms to use more than one energy substrate at a time, and to switch their catabolism from breaking carbon-carbon bonds to forming new carbon-carbon bonds, has only been studied to a small extent. Further, knowledge on the anaerobic degradation process is expected to evolve in the nearest future.

27810 (SLU-IMB–40, pp. 26-31) **Biogas reactors and ammonia - pure culture studies of methane bacteria.** Hansen, A. (Sveriges Lantbruksuniv., Uppsala (SE). Inst. foer Mikrobiologi); Svensson, B. Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish). (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

Biogas reactors works less efficient, when run with nitrogen rich substrates, which will cause an accumulation of ammonium. No thorough explanation for this has been put forward. It has been shown that the intracellular potassium concentration decreases and that the intracellular ammonium concentration increases upon treating pure cultures of methanogenic bacteria with ammonium chloride. This is believed to occur via the base, ammonia, which probably passively diffuse over the membrane. Inside the cell it picks up a proton and an equilibrium will be established between ammonia and ammonium, which is mainly determined by the cytoplasmic pH. This will result in an increased intracellular pH. To overcome this the cell probably pumps out potassium in exchange of protons via an antiporter. Ammonium and potassium are quite similar in size, 1.43 and 1.33 Angstrom crystal ionic radii respectively, and are in most cases able to substitute for each other as co-factors for enzymes. Due to this ability the exchange of potassium for ammonium in methanogens is probably not the reason for the ammonium inhibition.

27811 (SLU-IMB–40, pp. 32-39) **The influence of sulfate concentrations on the methane production in anaerobic reactors.** Petersen, S.P. (Danmarks Tekniske Hoejskole, Lyngby (DK). Inst. for Bioteknologi); Ahring, K. Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Danish). (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

Sulfate reduction and methane production are important processes in the anaerobic degradation of organic matter. Several investigations have demonstrated, that sulfate may have a restrictive influence on the production on methane in natural ecosystems as well as in sewage sludge digesters. In the paper, we review the existing knowledge of the interaction between sulfate reducers and methane producers in biogas digesters. Preliminary results from an investigation concerning the competitive relationship between sulfate reducers and methane producers under thermophilic conditions are presented.

27812 (SLU-IMB–40, pp. 40-47) **The microbiology of waste degradation in landfills.** Archer, D.B. (Agricultural and Food Research Council, Norwich (UK). Inst. of Food Research). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish, English, Norwegia (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

A significant proportion of the U.K.'s projected energy needs could be met through landfill methane production. In order to realise this potential, account must be taken in landfill management of the microbiology and biochemistry involved in waste degradation in a heterogeneous environment of high solids content. Detailed biochemical pathways of refuse degradation under landfill conditions are difficult to study and are consequently poorly understood. Similarly, little is known of the microbiology of landfill, although a picture of the degradative events occurring in landfill can be tentatively constructed from the limited studies so far conducted, and by analogy with other methanogenic ecosystems. The rates and extent of methane production from landfills vary and the opportunity to exert the most effective control over refuse degradation has already been lost once the refuse has been landfilled. On the other hand, landfill leachate is amenable to anaerobic digestion in purpose-built bioreactors. The impact of a microbiological approach to optimise methane production from refuse is likely to be greatest in purpose-built reactors or in the controlled deposition of refuse in biofills. These environments allow scope for manipulation of the physical conditions, nutrient status, microbial activities and degradative pathways involved in methane production from waste.

27813 (SLU-IMB–40, pp. 48-53) **"Psychrophilic" production of biogas.** Svensson, Bo (Sveriges Lantbruksuniv., Uppsala (SE). Inst. foer Mikrobiologi). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish). (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

A brief discussion about the non-relevant use of the terms psychrophilic and psychrotropic in the biogas literature is presented. The microbiological definitions are given and features developed by microorganisms experiencing changes in their surrounding temperature regime with special reference to low temperatures are discussed. Further some of the rational for the utilization of low-temperature biogas reactors is brought into focus.

27814 (SLU-IMB–40, pp. 54-61) **Mechanisms for granule production in UASB reactors.** Winther-Nielsen, M. (Danmarks

Tekniske Hoejskole, Lyngby (DK). Inst. for Bioteknologi); Ahring, B.K. Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Danish). (CONF-8812133--: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

The UASB process depends on the development of a highly settleable biomass in the reactor, either in the form of flocs or as dense granules. This is achieved through a carefully controlled initial start-up procedure, in which undesirable low density seed sludge components are allowed to wash out of the reactor, while active biomass of more preferable settling properties are retained. The occurrence of granulation and the factors responsible for granulation are not yet fully understood. Important parameters suggested in published research work are covered. The selection pressure originating from the hydraulic loading rate and the gas loading, the type of the involved microorganisms, and the influence of the wastewater composition are considered. The initial adhesion has been described using theories from the colloid chemistry. Laboratory scale experiments with thermophilic UASB-reactors are presented.

27815 (SLU-IMB--40, pp. 62-65) **Anaerobic bacteria and interfaces.** Szewzyk, U. (Goeteborgs Univ. (SE). Inst. foer Marin Mikrobiologi). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish, English, Norwegia (CONF-8812133--: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

Most anaerobic bacteria live in the presence of high amounts of particulate matter in their natural environment (e.g. sediments, digestors, rumen). Therefore it is interesting to study if the bacteria are in some way dependent or influenced by surfaces. Examination of bacteria living in close association with surfaces by necessity require enrichment and cultivation methods which allow the bacteria to attach to surfaces all the time. Such methods avoid a selection for bacteria growing preferential in liquid media. Bacteria isolated by such methods were used to study the influence of different surfaces, especially of FeS, which is the main constituent in anaerobic sediments, on the activity and viability. In addition these bacteria were used as inoculum for anaerobic fixed bed reactors for the degradation of different aromatic substances.

27816 (SLU-IMB--40, pp. 66-79) **Use of a mass spectrometer for on-line measurement and control of thermophilic, anaerobic fermentation processes.** Norddahl, B. (Dansk BioMiljoe, Odense (DK)). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Danish). (CONF-8812133--: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

A mass spectrometry method for the analyses of volatile compounds in solutions based on the membrane-inlet technique involving the utilization of a simple quadrupole instrument is presented. A solution with the volatile compounds passes a polymembrane selectively permeable to these compounds and the analyses set up will give momentary pictures of changes in their concentrations. Membrane systems, able to stand aggressive and inhomogeneous solutions are available which allow analyses of industrial waste waters and manure also in the thermophilic temperature range. Examples are given, where the method has been used to regulate the oxidation of methane by methanotropic bacteria by registrating the CH_4, O_2 and CO_2 in the culture liquid. For regulation of the biogas process H_2, CO_2, H_2 as well as volatile fatty acids, can be followed. A concept for a thermophilic two step biogas process is presented as well as a laboratory scale set up for the coupling of a one step thermophilic process in series with a two step reactor.

27817 (SLU-IMB--40, pp. 80-89) **Fermentation of algae sludge.** Hanssen, J.F. (Norges Landbrugshoegskole, Aas (NO). Mikrobiologisk institutt). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Norwegian). (CONF-8812133--: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

Marine brown algae are used for production of alginate. In Norway Protan A/S, Drammen harvest Laminaria sp. and Ascophyllum nodosum along the Norwegian western coast for production of alginate. About 160000 tons fresh weight per year are harvested. The amount of precipitation and flotation sludges from the alginate production is estimated to 14000 ton dry weight per year. The sludges from the alginate production contain a high fraction of organic matter (75-80 % VS). Since the sludges from the alginic acid extraction process are considered as bulky wastes with a high pollution load a research programme on anaerobic digestion of these residues has been started. Preliminary results have shown that the sludges can be digested with a high yield of methane (0.15-0.30 m^3/kg VS added).

27818 (SLU-IMB--40, pp. 90-95) **Biogas from forest industry waste water.** Malmqvist, Aa. (Anox AB, Lund (SE)); Peijie, Yu. Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish). (CONF-8812133--: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

Forest industry wastewaters often contain toxic compounds which can complicate the use of an anaerobic treatment process. Therefore, to obtain both high treatment efficiency and biogas production, a specific process is needed for each type of wastewater. Some possible solutions for sulphite evaporator condensate, bleach effluent and CTMP effluent are presented.

27819 (SLU-IMB--40, pp. 102-107) **Recirculation of process water in two-stage digestion.** Mathisen, B. (Jordbrukstekniska Institutet, Uppsala (SE)); Gissen, M. Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish). (CONF-8812133--: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

A two-stage digestion of grass-clover silage was studied, using a CSTR for the first stage and a hybrid reactor for the second. Retention time in the first stage was 9 days and in the second 6 days. After hydrolysis the solids were removed and the liquid was treated in the hybrid reactor. The digested liquid was mixed with silage and added back to the CSTR. Without liquid circulation the concentration of VFA was 7 g/l in the CSTR and the methane production was 1.8 l/l,d. When circulation was applied the production of VFA increased to 16 g/l and the methane production to 2.4 l/l,d. Also ammonia concentration increased from 0.5 to 2.1 g N/l due to an accumulation in the circulating liquid.

27820 (SLU-IMB--40, pp. 108-113) **The biogas potential of organic wastes in Sweden.** Thyselius, L. (Jordbrukstekniska Institutet, Uppsala (SE)). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish). (CONF-8812133--: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

At JTI an inventory has been made that gives an idea of the production of organic waste and waste water from different sectors of society as well as the maximum potential biogas production from such material. The total energy potential has been estimated at ca 16 TWh per year. Industry and municipalities contribute 3.1 and 2.2 TWh respectively but the agricultural sector is dominant with 10.5 TWh, of which 6.1 TWh comes from manure. The possible

extractable amount of energy from agriculture is judged to be 3.5 TWh. The total energy potential in practice would then be 8.8 TWh per year. At the energy price of SEK 0.25 per kWh this amount of energy would represent a value of MSEK 2200. The average load in the Swedish municipal digesters is 1 kg of organic matter per m^3 and day and the extracted energy is 0.4 TWh per year. If the load is increased to 2 kg of organic matter it would be possible yearly to handle further ca 250 ktons of organic matter. Solid waste from the food industry, 69 ktons of dry matter per year, lies within this digester capacity. Room for further 180 ktons of organic matter, for example energy crop or halm waste, is available. The total extraction of energy from the municipal digesters would then be ca 1.3 TWh per year.

27821 (SLU-IMB–40, pp. 114-122) **Energy production by anaerobic digestion of waste sludge from wood processing industries.** Vilppunen, P. (Univ. of Oulu (SF). Energy Laboratory). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish, English, Norwegia (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

This paper discuss case studies where anaerobic digestion may improve the waste sludge treatment from paper mill industries. The present way of sludge handling is briefly reviewed and reactor design criteria as well as process efficiencies are discussed.

27822 (SLU-IMB–40, pp. 123-128) **The straw/methane method.** Linne, M. (EnerChem AB, Lund (SE)); Dahl, A. Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish). (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

Large quantities of wheat straw is a residual material in the farm districts of Sweden. In order to demonstrate the possibility of converting crop residues into energy through anaerobic digestion three companies joined forces to build a 'farm-scale' plant. The aim is to prove the possibility of an economical process for a farm using a simple batch digester and the crop residue. The concept is a batch process with a high solid content and leachate recycle at 30 deg C. Two reactors are used. One rubber bag and one plastic bag each with a volume of 115 m^3. Previous laboratory-scale experiments over the past two years have resulted in 250 l biogas/kg dry matter. Digested sewage sludge, buffer and a nitrogen compound was added. In the laboratory, about 80 % of the total biogas production was obtained after 130 days. However, the addition of 10% grass has resulted in the same amount of biogas per kg dry solid in only half the production time.

27823 (SLU-IMB–40, pp. 129-132) **Field tests of enhanced degradation of household waste in a landfill.** Lagerkvist, A. (Luleaa Univ. of Tech. (SE). Div. of Residual Product Technology). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish, English, Norwegia (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

A new strategy for enhanced degradation of household wastes has been investigated at our laboratory: a two-step degradation of waste, where the first step 'reactor' typically consists of a landfill - or part of a landfill - where organic waste is (swiftly) deposited and compacted without the traditional adding of intermediate soil-cover. The aim is to establish and maintain an 'acid' degradation in this volume by recirculation of leachate. Thus a leachate with a low pH-value and high concentrations of fatty acids, metals etc can be drawn from this volume and fed to an external digester, where metals will be complex and adsorbed and organics in solution will be gasified to a large extent. Small scale models (approx. 100 litres) in our laboratory have given promising results - roughly equivalent with the results of available municipal waste digesters although at about 5-10 times slower reaction rates. This is a large step forward as compared to the traditional landfill. The slowness compared with the commercial digesters might very well be offset by the much lower cost per volume of this 'landfill-reactor' design. A field test unit has recently been built at the Soedra Sunderbyn landfill outside Luleaa and will become operative during the spring of 1989.

27824 (SLU-IMB–40, pp. 156-162) **Anaerobic filters for agricultural energy plants and industrial waste water plants.** Oestergaard, N. (Ramboell and Hannemann, Aarhus (DK)). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Danish). (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

According to Danish rules nitrogen and phosphorus loads on agricultural fields are maximun 170 and 30 kg per acre and year. Based on these demands, we planned rebuilding of a standard biogas plant for swine manure to combined separation, composting and anaerobic filter plant. Biogas production as m^3 biogas per kg VS added was between 0.28 and 0.36 at 30 deg C and about 0.48 at 35 deg C, under steady state conditions. Before dimensioning of anaerobic filter plants for wastewater from food processing industry 2 conditions have to be followed up: Reduced process water consumption, including process water recirculation and Separation of high and low strength wastewater. Investigations on a large brewery showed that 95% of the organic matter was to be found in 40% of the wastewater. Content of organic matter in the remaining wastewater was as low as to dilute the expected effluent organic matter concentration from fixed film filter. The direct pay back time will be about 4.5 years, according to present wastewater subscription.

27825 (SLU-IMB–40, pp. 163-168) **Experimental biogas plant at the Bollerup Agricultural School.** Hultman, M. (K-Konsult, Kristianstad (SE)). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish). (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

Building of a pilot plant for biogas production is planned at the Agricultural School of Bollerup in southern Sweden. Biogas from fermentation of crops, rest products and manure will be utilized for heating, electricity generation and fuel for farm management practices. Gas production efficiency obtained with different types of biomasses and different types of equipments, will be investigated, as well as economic consideration and management required, during a three year period. The plant is dimensioned to give an effect of ca. 50 kW, with a reactor volume of ca. 100 m^3 and a netto energy recovery estimated at ca. 220 MWh per year. The biomass needed to obtain this value is about 10 m^3 per day.

27826 (SLU-IMB–40, pp. 169-176) **Action plan for joint biogas plants.** Tafdrup, S. (Energistyrelsen, Koebenhavn (DK). Biogassekretariatet). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Danish). (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

The aim of the plan is to establish whether joint biogas plants can become economically competitive when agricultural and environmental advantages is combined with energy production. The plan consists of 8 demonstration plants, a follow-up programme, and information and research activities. The capacity of the demonstration plants range from 50 to 400 tons of biomass per day. The biomass is mainly manure collected from surrounding farms, in general supplemented with 'pure' organic wastes either from industry or as sewage sludge. By December 1988 four demonstration plants is in operation. Two plants are under construction, and two more plants has been decided.

27827 (SLU-IMB–40 p.96-101) **Aeration as a means to preheating in a full-scale biogas plant.** Ellegaard, A. (Bioquest HB, Vaestra Froelunda (SE)). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish). (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

Aeration was tried as a means to heat the incoming manure in a full-scale biogas plant. Air was injected into the fresh liquid manure, causing exothermic biochemical reactions to occur. The warm manure was then loaded into an anaerobic digester for further digestion and biogas production. The experiment was carried out in practical operation of the biogas plant for about four winter months. The aerobic process managed to maintain the operating temperature of the digester at 31 deg C, and only minute amounts of biogas were expended in order to keep the equipment from freezing. Gross biogas production decreased by 30 % compared to an average of four winter seasons. Net biogas available increased by more than 30 %. The economic result was similar in the two processes.

0910 Properties and Composition

Refer also to citation(s) 28361

0920 Combustion

Refer also to citation(s) 27839, 27939, 28293, 28294, 28347, 28362

27828 (PJM–CE02952, pp. 24-29, Paper 5) **Large scale systems.** Elliott, J. (H.A. Simon (International) Ltd., Vancouver, BC (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper describes and compares large scale (greater than 65,000,000 BTU/h) biomass-to-energy systems which use proven technology. Large scale systems are limited largely to combustion and steam generation systems. The main classifications by furnance configuration and fuel intake are: flat pinhole grate, steeply slopping pinhole grate, flat travelling grate, and suspension filing systems. The combustion chamber of the flat pinhole grate system is a water cooled intergral furnace. Air is admitted at two levels, lower pressure just over the bed and higher pressure higher in the furnance to obtain complete combustion. Ash accumulates on the floor of this system and must be cleaned away daily, a major disadvantage of the system. The steeply sloping pinhole grate system is very tolerant to variation in particle size and moisture content. Fuel is admited at the top of the slope and gravity pulls it down through drying, gasification, and burnout zones. Ash is remove mechanically on a continous basis. The entire bottom of the travelling grate furnance is a slow moving conveyor. Fuel is distributed over the entire surface. This system is very flexible as to fuel type and can be readily used when several solid fuels are anticipated. The suspension firing system, requires elaborate fuel preparation but can be readily used when several solid fuels are anticipated. It can totaly eliminate the need for fossil fuel. It can burn fuel combinations, and can be used to complete combustion of fuels from other sytems. Fuel preparation and handling is an important factor in use of these systems as some tolerate limited particle size range and require dry fuels. Fuel preparation systems are briefly discussed. 12 figs.

27829 (PJM–CE02952, pp. 19-23, Paper 4) **Small scale systems.** Levelton, B. (B.H. Levelton and Associates Ltd., Vancouver, BC (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper describes and compares small scale (less than 65,000,000 BTU/h) biomass-to-energy systems which use proven technology. Four categories of processes are described. Processes which produce non-combustible gases burn wood to produce an inert hot gas which can be used for process heat, for producing steam, for heating kilns and for space heating. These systems represent the largest number of systems currently in use. The second system produces a hot process fluid, most usually a hot oil which is used for process heat. Gasification processes pyrolize wood to produce a combustible gas. Gasification is of special interest because of its potential to produce useful fuels. Usually the gas is of low heating value and contains tars and particulates. Finally steam boiler systems burn wood to produce steam. Most steam boilers generate under 10,000,000 BTU/h and are used where only a small amount of steam is required as for space heating. Some evaluations of vended systems is provided.

0930 Economic, Industrial, and Business Aspects

Refer also to citation(s) 28155, 28287, 28362

27830 (PB–90-159286/XAB) **Methanol demand, supply, and prices: 1970-2000.** Holtberg, P. Gas Research Inst., Chicago, IL (USA). Jul 1989. 99p. (GRI–89/0302). Available from NTIS, PC A05/MF A01.

The historical development of methanol markets as they pertain to the U.S. are described along with the mix of products using methanol, U.S. and worldwide production capacity, and methanol prices. The issues impacting future methanol demand are examined; available projections of methanol demand and price are summarized; and a projection of methanol demand, supply, and price consistent with the 1988 GRI Baseline Projection is provided.

27831 (PJM–CE02952, pp. 96-100, Paper 18) **[Biomass fuels] An industry perspective.** Edwards, W.C. (B.H. Levelton and Associates Ltd., Vancouver, BC (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper discusses the possibilities existing in British Columbia to increase the use of biomass fuels in the industrial, institutional, and commercial sectors. Wood waste currently supply about 24%, and waste liquor about 37% of energy needs in the British Columbia forest products industry. Projected demand in the industry for wood fuels in central B.C. will consume about 39% of local supply by 1985 and 45% by 1995. In the costal areas demand will outstrip supplies by 1985. Possibilities for utilizing the oversupply in central B.C. include direct use by other industries, cogeneration of electricity for plant requirements and sales to local utilities. Densification of biomass fuels would be necessary to make transportation to offsite users attractive. Large institutions are potential customers if the problems associated with the conversion of heating systems to biomass fuels can be solved. Candidate fuels for institutional heating include, wood residue, municipal solid wastes, sewage derived biogas, and food processing wastes. Heating of commercial buildings with biomass fuels is a potential if the problems of low density, storage requirements, and seasonal supply of fuel can be overcome. Factors affecting the ultimate acceptability of biomass conversion systems include: fuel type, financing, operating labour requirements, system reliability, environmental factors, and market cost of traditional fuels.

27832 (PJM–CE02952, pp. 8-10, Paper 2) **Economics of bioenergy technology.** Juneja, S. (Energy, Mines and Resources Canada, Ottawa, ON (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The objective of this presentation was to analyse the factors that make an economically viable wood energy system. Two types of sytems were discussed; large system such as currently can be

found in pulp and paper mills and small system such as can currently be found in saw mills and furniture plants. Three economic considerations were evaluated; the difference in cost between the wood fuel and the present fuel; the annual fuel comsumption; and the capital and operating costs of the project. Oil prices were evaluated at two levels, $23.90/barrel and $30.12/barrel. Wood waste prices were evaluated at three levels; $0.00, $16.00 and $32.00 per wet ton. The capital cost for the large system was estimated at $30,000,000 with an estimate life of fifteen years. Maximum annual fuel saving for the large system was 372,000 barrels of oil, that for the small system was 23,800 barrels of oil. The difference in fuel costs was shown to have the strongest effect on profitability. At a wood price of $16/wet ton and and a price of $25/barrel for oil a profitability of 8% and 13% respectively is predicted for the large and small system. A $30/barrel the profitability rose to 13% and 25%. The break-even point is about $18.00/barrel. At a wood price of $0.00 and (a case that obtains in many sawmills), profitability rose to 16% and 40% respectively for large and small systems. If a mill were currently paying a fee to have waste wood hauled away, profitability would be still higher.

27833 (PJM–CE02952, pp. 101-104, Paper 19) **An economic perspective on bioenergy projects.** McDaniels, T. (McDaniels Research Ltd., Vancouver, BC (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper discusses the economic perspective of bioenergy use in Canada from the private financial and the public sector viewpoint. The economic role of the Forest Industries Renewable Energy (FIRE) program is discussed. A private sector financial analysis would estimate the capital, operating and other extraordinary costs of the project and the revenues or cost savings; it would then conduct a discounted cash flow analysis to estimate return on investment. In order to attract private investment a project would have to pay back costs as fast or faster that competing investments. The public sector needs to analyze the public good which will result form such a program. The author proposes the use of an analytical tool called social benefit (cost analysis) to apply cost/benefit techniques to the assessment of how society as a whole is affected by a given bioenergy investment. The most significant potential benefit of a bioenergy project is the energy savings or the reduction of oil consumption by substitution a product previously treated as waste. Other social benefits include the creation of local employment, environmetal benefits resulting from waste utilization, and contributions to technological advance. The FIRE program is an attempt to reconcile the stringent financial criteria for private investment with the potential social benefits which are apparent when social benefit analysis is applied.

0950 Environmental Aspects

Refer also to citation(s) 27837, 28287

0960 Health and Safety

27834 (LIS–88) **Safety analysis of a process plant according to a modified PAAG procedure for a liquefied gas storage facility.** Euteneuer, U.; Katzer, H.; Wefers, H. Landesanstalt fuer Immissionsschutz des Landes Nordrhein-Westfalen, Essen (Germany, F.R.). 1989. 136p. (In German). Available from Copy held by UB/TIB Hannover.

Large chemical industries increasingly apply systematic methods for checking the safety of its technical equipment. The Second General Administrative Rules to the Inadvertent-Release Act demand systematic analyses of all equipment which is important for technological safety. Of the numerous systematic methods applied in safety and operability analysis, the PAAG-procedure (prediction, spotting the cause, estimating the effects, countermeasures) has the reputation of being the most thorough one because all possible sources of danger within the facility or in its environment can be recognized. However, documentation of systematic safety checks of facilities is not yet customary when performing safety analyses as required by the Inadvertent-Release Act. The report describes the procedure for determining the safety of a planned liquid propane gas storage facility by the PAAG-method. Aside from describing the procedure, every step is explained so that it can be reproduced. (orig./MG).

27835 (SLU-IMB–40, pp. 177-182) **Animal hygienic aspects of operation of joint biogas plants.** Ammendrup, S. (Veterinaerdirektoratet, Koebenhavn (DK)). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Danish). (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

In cattle- and pigherds many different infectious diseases occur and apparently healthy as well as sick animals can shed pathogenic microorganisms through feces, urine and various secretions. Handling of manure - especially while still fresh - offers a certain risk of transmission of infections. The management of common biogas plants implies transporting manure over longer distances, mixing of manure from various herds and finally distribution for manuring to various fields. This in turn implies an increased risk of transmission of infections to other herds. Such an increased risk must be met with adequate safeguard measures when handling manure - collection, transport and unloading as well as the processing at the plant. In addition to general hygienic principles specific safeguard measures should be applied. The present knowledge of reduction of infectious matter in slurry and manure is based mainly on laboratory experiments. Therefore, a veterinary programme was introduced in connection with 'The action-plan for common biogas plants of the Ministry of Energy, May 1987'. The aim of this programme is to obtain further knowledge and thereby being able to elaborate more exact hygienic criteria necessary for the processing of manure if the risk of inter-herd infections shall be minimized.

0980 Waste Management

Refer also to citation(s) 27838, 27839, 28290, 28291, 28292, 29029

27836 (PJM–CE02952) **Proceedings of the conference on biomass: An alternative source of energy.** Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. 144p. (CONF-8211204–: ; CE–02952). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The purpose of this conference was to heighten awareness of the technical and economic value of biomass as an energy source and to explain the role of the Canadian government in assisting public and private sector organizations in the use of biomass as a source of fuel. Speakers included experts involved in the successful implementation of bioenergy technology. The following topics were covered: new potentials for bioenergy use, the economics of bioenergy technology, energy from municipal waste, the Canadian government's Forest Industry Renewable Energy Program, and international aaspects of bioenergy use. Case studies are provided on the use of wood, municipal and agricultural wastes for energy production. Separate abstracts have been prepared for 25 papers.

27837 (VTT-TIED–1060) **Waste waters from biomass synthesis gasification processes.** Fagernaes, L. (Valtion teknillinen tutkimuskeskus, Espoo (Finland). Polttoainejalostustekniikan laboratorio). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Sep 1989. 77p. (In Finnish). Order Number DE90770752. Available from NTIS (US Sales Only), PC A05/MF A01.

Processes developed for biomass synthesis gasification are U-GAS, PEATGAS, High-Temperature-Winkler, Mino, Omnifuel and Creusot-Loire. However, there is so far only one commercial biomass synthesis gasification plant in operation in the world: the peat ammonia plant of Kemira Oy In Finland. Waste waters from processes with wood, peat and wastes as raw materials have been studied in laboratory and pilot units and at demonstration plants. In synthesis gasification, waste waters are formed in biomass drying,

and in gas cooling, scrubbing and conversion. Waste water contains solids, ammonia, cyanide, phenol, benzene and polyaromatic compounds, quantities found are highly dependent on the gasification process used and on process conditions, such as pressure and temperature, amount of scrubbing water, and waste water recirculation. The process waste waters require treatment before their release into watercourses or to a municipal purification plant or before recirculation. The treatment required is completely dependent on the concentration, amount and use of the waste water. Requirements set by the authorities and the maximum contents set on waste waters also vary in different regions and countries. Methods suited for the treatment of waste waters are solids removal, for example, by centrifugation or filtration, ammonia removal by steam stripping and phenol removal by extraction, and, after pretreatment, treatment at a biological purification plant.

0990 Products and By-Products

Refer also to citation(s) 28298, 29167

27838 (SLU-IMB–40, pp. 133-137) **Biogas from kitchen wastes.** Forslund, E. (PLM Sellbergs, Stockholm (SE)). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish). (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

Kitchen waste consists of waste from catering services and waste from households. Both groups are well suitable for fermentation. Today most of the kitchen waste is integrated in household waste in the Nordic countries. It is not common to separate the kitchen waste, except for a small part which goes directly to animal feeding stuff. Nowadays there is, however, certain interest in separation and pre-sorting and some small experiments have been made. In Denmark a plant is under construction, where the moist part of the household waste is separated. This fraction could very well be suitable for fermentation. However, a composting process has been chosen. In the rest of the Nordic countries there are now plans forwarded in the same direction.

27839 (STEV-FBT–89-51) **Phase analysis of sintered and non-sintered straw with and without kaolin or dolomite additions.** Steenari, B.M. (Chalmers Univ. of Tech., Goeteborg (SE). Dept. of Inorganic Chemistry); Langer, V. Statens Energiverk, Stockholm (Sweden); Chalmers Univ. of Tech. and Univ. of Goeteborg, Goeteborg (Sweden). Dept. of Inorganic Chemistry. 1988. 60p. (In Swedish). Project STEV-276-382. (CTH-OOK–88-12). Order Number DE90770775. Available from NTIS (US Sales Only), PC A04/MF A01.

The content of crystalline compounds in straw ashes was investigated in order to describe their sintering properties. Totally 17 samples of rape, wheat and barley straw were analyzed by X-ray diffraction. In addition a closen study on the melting process and influence of additives was done with one sample of each kind of straw. To the straw samples were added respectively kaolin and dolomite, where upon the samples were heated. After that the X-ray driffraction analyses were repeated. The results of these investigations show that the crystalline compounds found in the straw ashes are of a similar sort in all three straw kinds. It is a question of relatively simple compounds like SiO_2, $CaCO_3$, KCl, K_2SO_4, $K_2Ca(CO_3)_2$. Any possible connvections between growing conditions and contents of crystalline compounds were not demonstrated. In the later part of the work was shown that reactions take place between substances in the straw ash and the additives kaolin and dolomite. In the case of koalin potassium compunds in all of the straw ashes reacted with kaolin. That is favourable from sintering point of view, as the reaction products $KAlSiO_4$ and $KAlSi_2O_6$ have considerably higher melting points than for example KCl and K_2SO_4. In the dolomite test $CaMg(SiO_3)_2$ was formed from wheat straw and $CaMgSi_2O_7$ from barley straw. These products do not increase the melting points. In addition the potassium containing compounds are still present with their low melting points and may cause local melts and sinterings. (4 figs., 9 tabs., 11 refs.).

10 SYNTHETIC FUELS

1002 Production

Refer also to citation(s) 27409, 27410, 27411, 27412, 27416, 27417, 27418, 27419, 27427, 27596, 27597, 27598, 27599, 27600

27840 (AD-A–216444/0/XAB) **Production of high-density aviation fuels via novel zeolite catalyst routes. Final report, December 1985-May 1987.** Hanson, F.V. Utah Univ., Salt Lake City, UT (USA). Dept. of Fuels Engineering. 23 Oct 1989. 484p. Available from NTIS, PC A21/MF A03.

The production of high density aviation fuels from reliable, domestic fossil fuel sources is of considerable importance to the United States Air Force. The production of high density aviation fuels can be achieved by a number of alternative process sequences, for example, shape selective cracking of normal paraffins from an appropriate boiling range fraction of a napthenic crude; saturation of an aromatic FCC cycle stock of the appropriate boiling range; saturation of an appropriate boiling range fraction from a hydrocracker recycle stream when the feed to the hydrotreater is aromatic in nature; synthesis of the appropriate boiling range aromatic species from oxygenates over crystalline aluminosilicates followed by hydrogenation of the aromatic species; and direct synthesis of the aromatic hydrocarbons from hydrogen and carbon monoxide over crystalline aluminosilicate-supported metal catalysis followed by hydrogenation of the aromatic species. This report summarizes a research program aimed at developing catalyst and processing concepts for the production of high density aviation turbine fuels via novel zeolite catalyst routes.

27841 (CONF-891131–, pp. 85-102) **Optimum catalytic process for fuel alcohols from syngas.** Dombek, B.D. (Union Carbide Corp., South Charleston, WV (USA)); Sheffer, G.R. US-DOE Pittsburgh Energy Technology Center, PA (USA). [1989]. DOE Contract AC22-86PC90013. From Indirect liquefaction contractors' review meeting; Pittsburgh, PA (USA); 13-15 Nov 1989. In *Indirect liquefaction.* Order Number DE90008422. Available from NTIS, PC A20/MF A01.

The objective of the authors research is to discover and evaluate novel catalytic systems for the selective conversion of synthesis gas into a mixture of alcohols useful as a fuel extender or octane enhancer. These systems include both homogeneous and heterogeneous catalysts, and may involve two-stage operation through methanol. Early contract work included further development of a novel, rhodium-based, low pressure (< 1,000 psi), methanol homologation process discovered under the authors previous contract. In addition, homogeneous ruthenium-based catalysts have been studied for synthesis gas conversion to C_1-C_4 alcohols at 3,000-5,000 psi pressure. Their work has resulted in the development of novel catalyst additives that increase both the activity and selectivity to higher alcohols. Heterogeneous molybdenum sulfide catalysts have been investigated with the objective of discovering new methods of modifying the catalyst to improve performance. Certain additives have been demonstrated to have a beneficial effect, but significant improvements in catalyst performance have not been realized. Their most recent work has been the development of heterogeneous catalysts consisting of one or more transition metals on mixed metal oxide supports with the spinel structure for synthesis gas conversion to normal alcohols. Alcohol yields as great as 13 lbs/ft^3 catalyst/hr have been observed with further improvement expected. Slurry phase reaction studies of both the molybdenum sulfide and transition metal/spinel based catalysts are planned.

27842 (EGG-M–90040) **High temperature ceramic-tubed reformer.** Williams, J.J. (Stone and Webster Engineering Corp., Boston, MA (USA)); Rosenberg, R.A.; McDonough, L.J. EG and G Idaho, Inc., Idaho Falls, ID (USA). Mar 1990. 37p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FC07-88ID12797. (CONF-900391–5: 1990 American Institute of Chemical Engineers (AIChE) spring meeting, Orlando, FL (USA), 18-22 Mar 1990). Order Number DE90009617. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The overall objective of the HiPHES project is to develop an advanced high-pressure heat exchanger for a convective steam/

methane reformer. The HiPHES steam/methane reformer is a convective, shell and tube type, catalytic reactor. The use of ceramic tubes will allow reaction temperature higher than the current state-of-the-art outlet temperatures of about 1600°F using metal tubes. Higher reaction temperatures increase feedstock conversion to synthesis gas and reduce energy requirements compared to currently available radiant-box type reformers using metal tubes. Reforming of natural gas is the principal method used to produce synthesis gas (primarily hydrogen and carbon monoxide, H_2 and CO) which is used to produce hydrogen (for refinery upgrading), methanol, as well as several other important materials. The HiPHES reformer development is an extension of Stone & Webster's efforts to develop a metal-tubed convective reformer integrated with a gas turbine cycle. 9 figs., 1 tab.

27843 (IFP–37-451) **Oxidative coupling of methane on rare earth oxide catalysts.** Kooh, A. Ecole Nationale Superieure du Petrole et des Moteurs (ENSPM), 92 - Rueil-Malmaison (France); Paris-6 Univ., 75 (France). 1989. 111p. (In French). Order Number DE90773308. Available from NTIS (US Sales Only), PC A06/MF A01.

The oxidative coupling of methane reaction, producing ethane and ethylene, was studied over pure lanthanum oxide, lithium doped lanthanum oxide and barium doped lanthanum oxide catalysts in the cofeed mode between 700 and 950°C and at atmospheric pressure. The ethane and ethylene yields increase with increasing catalyst bed hot point temperatures and flow rate. Over pure lanthanum oxide, yields of the order of 10-11% are obtained with hot point temperatures in excess of 850°C and with reactant flow rates (methane and oxygen only) greater than 1500 ml/min, corresponding to linear space velocities of the order of 0.65 m/s. The reaction obeys Langmuir-Hinshelwood kinetics where methane and oxygen are non-competitively absorbed on the catalyst surface; hydrogen atom abstraction from methane is the rate limiting step. Oxygen absorption appears to be non-dissociative. At low methane conversion, ethylene is the only product resulting from consecutive reaction of ethane. Carbon oxides are formed directly from non-selective reactions with methane. We suggest that the formation of carbon dioxide results from the reaction between surface oxygen species and elemental carbon. The latter being formed by the decomposition of methane to its elements at the temperature of reaction. In contrast, carbon dioxide is proposed, in the literature, as the consecutive oxidation product of carbon monoxide.

1007 Economic, Industrial, and Business Aspects

Refer also to citation(s) 27410

13 HYDRO ENERGY

Refer also to citation(s) 27860

1303 Plant Design and Operation

27844 (SHEC–CE02959) **Hasty Creek small hydro project report.** British Columbia Ministry of Energy, Mines and Petroleum Resources, Vancouver, BC (Canada). Conservation and Technology Div.; Small Hydro-Electrics Canada Ltd., Silverton, BC (Canada). [1990]. 14p. (CE–02959). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This project involved connecting the Adela Corporation's 37.5 kW small hydro plant at Hasty Creek, Silverton, British Columbia (B.C.) to B.C. Hydro and Power Authority's provincial grid. The connection was successfully accomplished, and Hasty creek became the first privately-owned small hydro installation to supply power to the grid. The total cost of the project was Canadian $31,800, of which Canadian $24,000 was provided by the Canada/B.C. Conservation and Renewable Energy Demonstration agreement. The capital cost of the work was $18,800, which included; design and installation of electical control and protection system metering, system protection and automatic shutdown; supply and installation of a 37.5 kW, 1200 rpm induction generator; supply and installation of electrical transmission line and tranformers to link the power house to the B.C. Hydro system. The control and protection system is operating well. The hydroelectric plant itself was subject to minor mechanical malfunctions in the intake manifold and one needle nozzle system, which resulted in loss of production; these malfunctions have been corrected. The system is expected to supply 193,000 kWh of electricity annually to B.C. Hydro, worth Canadian $7,681 at the current rates being paid by Hydro. Thus, the economics of this connection are attractive. The demonstration showed that a privately-owned small hydro installation can safely and economically supply power to the grid. Grid-connected small hydro has the potential of delaying the need for constructing large generating facilities in B.C. 1 tab.

1305 Economic, Industrial and Business Aspects

Refer also to citation(s) 27844, 28122

1306 Environmental Aspects

27845 (DOE/BP/63461–3) **Augmented fish monitoring, Project 86-54: Annual report 1988.** Michak, P. (Washington State Dept. of Fisheries, Olympia, WA (USA)); Rogers, B.; Chapman, P.; Amos, K. USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Fish and Wildlife; Washington State Dept. of Fisheries, Olympia, WA (USA). Jan 1990. 156p. Sponsored by U.S. DOE Management & Administration. DOE Contract BI79-86BP63461. Order Number DE90009376. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Since 1986 Washington department of Fisheries (WDF) has participated in the Columbia Basin Augmented Fish Health Monitoring Project. This project provides a standardized level of fish health information from all Agencies rearing fish in the Columbia Basin. WDF has actively participated in this project, and completed its second year of fish health monitoring, data collection and pathogen inspection during 1988. This report will present data collected from January 1, 1988 to December 31, 1988 and will compare sampling results from 1987 and 1988. The analysis will be divided in two sections: adult analysis and juvenile analysis. The adult analysis will include results from screening at spawning for viral pathogens and bacterial kidney disease (BKD), and evaluation of causes of pre-spawning loss. The juvenile analysis will include pre-release examination results, mid-term rearing exam results and evaluation of the Organosomatic Analysis completed on index stocks. Additionally, highlights from monthly monitoring exams will identify any significant and unusual findings from the routine exams completed in 1988. 6 refs., 8 figs., 14 tabs.

27846 (PNL–7289) **Spawning and abundance of fall chinook salmon (Oncorhynchus tshawytscha) in the Hanford Reach of the Columbia River, 1948–1988.** Dauble, D.D.; Watson, D.G. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 66p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90008204. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Hanford Reach of the Columbia River provides the only major spawning habitat for the upriver bright (URB) race of fall chinook salmon in the mainstem Columbia River. Hanford Site biologists have conducted aerial surveys of spawning salmon in the Hanford Reach since 1948. This report summarizes data on fall chinook salmon spawning in the Hanford Reach and presents a discussion of factors that may affect population trends. Most data are limited to fisheries agency reports and other working documents. Fisheries management practices in the Columbia River system have changed rapidly over the last decade, particularly under requirements of the Pacific Northwest Power Planning and Conservation Act of 1980. New information has been generated and included in this report. 75 refs., 17 figs., 11 tabs.

14 SOLAR ENERGY

Refer also to citation(s) 28150

27847 Getting the solar message to the layman. Poore, A.V. (Sandia National Lab., Albuquerque, NM (USA)). *Solar Today (USA),* 3(6): 23-24 (Nov-Dec 1989).

The author describes ways in which solar technology documentation can be presented to a non-technical audience without sacrificing accuracy. She stresses the importance of a planning session to determine the intended audience before deciding on content. Limiting detail, avoiding acronyms and pretentious language an defining terms will help capture the reader. The author recommends the use of software packages for word processors that check for spelling, grammer, syntax, readership level and clarity.

1401 Resources and Availability

27848 (SERI/PR–215-3607) **Photovoltaic Advanced Research and Development Project: Solar radiation research: Annual report, 1 October 1988–30 September 1989.** Riordan, C.; Hulstrom, R.; Cannon, T.; Myers, D.; Stoffel, T. Solar Energy Research Inst., Golden, CO (USA). Feb 1990. 23p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE90000302. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report summarizes the activities and accomplishments of SERI's Photovoltaic Advanced Research and Development Project task on Solar Radiation Research from 1 October 1988, through 30 September 1989. The objective of this task is to support the National Photovoltaics Program by helping to develop a fundamental scientific understanding of the relationships between the natural solar radiation environment and the design, performance, and performance measurements of PV devices. The activities that are summarized in the report include (1) the development of the Atmospheric Optical Calibration System for measuring solar radiation and atmospheric optical conditions during outdoor PV tests; (2) the development of an extended-wavelength (290–3000 nm) spectroradiometer for measuring outdoor and simulator spectra; (3) data collection and analysis for PV applications at SERI's Solar Radiation Research Laboratory; and (4) collaborative activities, measurement support, and technical information transfer. 20 refs., 8 figs.

1405 Solar Energy Conversion

Refer also to citation(s) 27802, 27848, 28552

27849 (AD-A–216857/3/XAB) **Radiation-hard high-efficiency InP space solar-cell development. Quarterly progress report for 12 August-11 November 1989.** Spire Corp., Bedford, MA (USA). Dec 1989. 33p. (SPIRE-QR–10120-02). Available from NTIS, PC A03/MF A01.

This quarter was marked by two serious problems which have delayed fabrication and delivery of the cells. The first of these problems, the failure of the front contact metallization, was solved in early November. The second problem, the abnormally low open-circuit voltages and fill factors, was not solved as of the end of the quarter, although promising indications have been seen in the interval between the end of the reporting period and this writing. Despite thes problems, we were able to continue work on the emitter structures; advanced thin emitters have been grown without any post-growth thinning step and have demonstrated improved quantum efficiency. Development of the processing sequence has continued as well; details of the back contact formation process have been elucidated in order to give maximum flexibility for the processing of thin cells.

27850 (PB–90-159625/XAB) **Consumer effects of biotechnology. Agriculture information bulletin.** Reilly, J.M. Economic Research Service, Washington, DC (USA). Dec 1989. 14p. (USDA/AIB–581). Available from NTIS, PC A03/MF A01.

Expectations regarding biotechnology have cycled through booms and busts, but biotechnology appears to be growing rapidly. Biotechnology has moved from university laboratories and small companies focused on biotechnology research to large industrial companies, which are prepared to use the products and processes of biotechnology to improve their production processes and to expand product lines.

27851 (PB–90-164286/XAB) **MERCHOP (Merchandising Optimizer): A dynamic programming model for estimating the harvest value of unthinned loblolly and slash pine plantations. Forest Service research paper.** Busby, R.L.; Ward, K.B. Forest Service, New Orleans, LA (USA). Southern Forest Experiment Station. 1989. 23p. (FSRP-SO–254). Available from NTIS, PC A03/MF A01.

A model was devised to estimate the harvest value of unthinned loblolly and slash pine (pinus taeda L. and P. elliottii var. elliottii Englm.) plantations in the west gulf region. The model, MERCHOP, can be used to forecast product volumes and values; the output provided is partitioned into 1-inch tree d.b.h. classes. Using a dynamic programming algorithm, MERCHOP can be used to convert stand tables predicted by USLYCOWG's three-parameter Weibull function into a listing of seven products that maximizes the selling value of the stand, assuming the assumptions used in the analysis are correct.

27852 (PB–90-859695/XAB) **Optical coatings. November 1983-December 1989 (A Bibliography from the NTIS dat abase). Report for November 1983-December 1989.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 81p. Available from NTISPC N01/MF N01.

Supersedes PB–86-877164.

This bibliography contains citations concerning the methods of application, properties, and evaluation of optical coatings. Reflective and antireflective coatings for thermal solar collectors, solar cells, and laser mirrors are among the topics discussed. Application methods performed in laboratory and industrial settings are described and evaluated. (This updated bibliography contains 133 citations, 56 of which are new entries to the previous edition.)

27853 (SAND–90-7026) **High-efficiency silicon solar cells for a 22-sun line-focus module.** Silver, J.R. (Solarex Corp., Rockville, MD (USA). Aerospace Div.); Patel, B. Sandia National Labs., Albuquerque, NM (USA); Solarex Corp., Rockville, MD (USA). Aerospace Div. Feb 1990. 21p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. Order Number DE90010242. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this program was for Solarex, a commercial silicon solar cell supplier, to demonstrate the capability of fabricating high efficiency 38.4 cm^2 concentrator cells in a production environment. These cells were designed for use in 22-sun line-focus concentrator module that could generate 20 kW for the PVUSA EMT-1 project. The cells were fabricated using p-type, .8 ohm-cm silicon, randomly textured fronts, dual-layer anti-reflective coatings, passivated emitters, restricted emitter/metallization contact areas, and silver gridlines with large cross-sectional areas. Prismatic covers were used to eliminate losses from gridline shadowing. Cell efficiencies as high as 20.34% were demonstrated on covered cells at 20 suns air mass 1.5 illumination. The process sequence includes a single diffusion step, a thin thermal oxide growth, and two mechanically registered photolithography steps. 13 figs., 3 tabs.

27854 (SERI/TP–211-3643) **Photovoltaic Program Branch annual report, FY 1989.** Summers, K.A. (ed.). Solar Energy Research Inst., Golden, CO (USA). Mar 1990. 280p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE90000318. Available from NTIS, PC A13/MF A01 - OSTI; GPO Dep.

This report summarizes the progress of the Photovoltaic (PV) Program Branch of the Solar Energy Research Institute (SERI) from October 1, 1988, through September 30, 1989. The branch is responsible for managing the subcontracted portion of SERI's PV Advanced Research and Development Project. In fiscal year (FY) 1989, this included nearly 50 subcontracts, with a total annualized funding of approximately $13.1 million. Approximately two-thirds of the subcontracts were with universities, at a total funding of nearly $4 million. The six technical sections of the report cover the main areas of the subcontracted program: Amorphous Silicon Research, Polycrystalline Thin Films, Crystalline Silicon Materials Research, High-Efficiency Concepts, New Ideas, and University Participation. Technical summaries of each of the subcontracted programs provide a discussion of approaches, major accomplishments in FY

1989, and future research directions. Each report will be cataloged individually.

27855 Outdoor stability performance of thin-film photovoltaic modules at SERI. Mrig, L. (Solar Energy Research Inst., Golden, CO (USA)). pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. IEEE Service Center, Piscataway, NJ (USA) (1989). DOE Contract AC02-83CH10093. (CONF-890815--: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899550.

Thin-film photovoltaic technologies are progressing rapidly towards the goal of becoming a low-cost power generation option. A large number of companies in the United States and abroad are working to increase the module efficiency, reduce manufacturing costs, and improve the reliability of thin-film devices. One of the activities of the Module Testing and Performance Group at the Solar Energy Research Institute (SERI) is to investigate and identify the reliability issues related with the development of emerging thin-film photovoltaic technologies. In that context, SERI has been conducting tests to study the outdoor stability performance of currently leading thin-film technologies of amorphous silicon (a:Si), copper indium diselenide (CIS), and cadmium telluride (CdTe) modules and submodules. This paper presents stability performance results from tests conducted at SERI on these thin-film material modules and submodules.

1406 Photovoltaic Power Systems

Refer also to citation(s) 27787, 27788, 27854, 27860, 28122

27856 (N--90-15836, pp. 84-96) **Lunar power system summary of studies for the lunar enterprise task force NASA-office of exploration.** Criswell, D.R. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Jul 1989. (NASA-TM--101652;NAS--1.15:101652). In *Report of NASA Lunar Energy Enterprise Case Study Task Force*. Available from NTIS, PC A09/MF A02.

The capacity of global power systems must be increased by a factor of ten to provide the predicted power needs of electric power by the year 2050. The Lunar Power System (LPS) would collect solar energy at power bases located on opposing limbs of the moon as seen from Earth. LPS can provide dependable, economic, renewable, and environmentally benign solar energy to Earth. A preliminary engineering and cash flow model of the LPS was developed. Results are shown for a system scaled to a peak capacity of 355 GWe on Earth and to provide 13,600 GWe-Yrs of energy over a 70 year life cycle of construction and full operation. The growth in capacity of the reference system from start of installation on the moon in 2005 to completion of its nominal life cycle in the year 2070 is shown. World needs for power could be accommodated by expansion in capacity of the reference LPS beyond 344 GWe. This would be done by steadily incorporating newer technology during full operation and by establishing additional bases. The results presented encourage consideration of a faster paced program than is assumed herein.

27857 (SV-US--1989-39) **100 kW_p solar cell power plant.** Andersson, M. (Institutet foer Mikroelektronik, Kista (SE)). Swedish State Power Board, Vaellingby (Sweden). 24 Oct 1989. 34p. (In Swedish). Order Number DE90770782. Available from NTIS (US Sales Only), PC A03/MF A01.

In this study a 100 kWp grid-connected solar power plant is described. The solar power plant is connected to the utility grid at the 20 kV level. The climatic conditions assumed come from data gatherd at Aalvkarleby Laboratory. They are representative for the middle part of Sweden. A detailed description of the components of the plant is given. Different desings are discussed and an estimation of costs and energy production is presented. Visits to some recently built European photovoltaic plants have been part of the sudy. They are briefly described and useful contacts persons are identified. The proposed plant has a maximal capacity of 106 kW (at standard test conditions (STC) i.e. an irradiance level of 1000 W/m^2 and a cell temperature of 25 degrees C) and the yearly energy production is calculated to 91 MWh. The total cost is estimated to 5.2 million SEK of which the solar cell modules stand for 2.8 million and the remaining 2.4 million cover more conventional equipment like support structures, cabling, inverter, control system and labour costs for installation. The space needed for the plant is approximately 4400 m^2.

1407 Solar Thermal Power Systems

27858 (DFVLR-IB--444-012/88) **TESOP. Test stand for solar process heat systems in the moderate temperature range. Interim report.** Koehne, R. (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Stuttgart (Germany, F.R.). Inst. fuer Technische Thermodynamik). Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Koeln (Germany, F.R.). Mar 1988. 9p. (In German). Contract BMFT 03E-8556-A. Order Number DE90779859. Available from NTIS (US Sales Only), PC A02/MF A01.

With the present test equipment the prerequisites for the optimum design of future solar process-heat systems in the middle temperature range for various industrial uses are to be created. Moreover existing simulation programs with which a computer forecast for typical plant sizes is possible are to be verified. Using a principal design, the construction and functions of the test equipment are described. (BWI).

27859 (SAND--90-0183) **An assessment of second-generation stretched-membrane mirror modules.** Alpert, D.J.; Houser, R.M.; Heckes, A.A.; Erdman, W.W. Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 72p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. Order Number DE90010243. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

For more than 10 years, the US Department of Energy's Solar Thermal Program has pioneered the development of heliostats, mirrors that track the sun, for solar central-receiver power plants. The field of heliostats is the single most expensive part of such plants, so their cost must be as low as possible for the technology to be commercially successful. Recent efforts have focused on the development of heliostats that use stretched-membrane reflectors in place of the more familiar glass mirrors. In such heliostats, metal foils are stretched over both sides of a large-diameter metal ring. The reflective surface is a silvered-polymer film glued to the front membrane. A slight vacuum in the space between the two membranes is actively controlled to provide a concave, focused contour to the mirror, and in an emergency this space can be rapidly pressurized to defocus it. Because of their simplicity and lighter weight, stretched- membrane heliostats have the potential to cost significantly less than current glass-mirror designs. The first 50-m^2 mirror modules, built under contract to Sandia in 1986, demonstrated that membrane heliostats could perform at least as well as heliostats using glass mirrors. Insights gained from Sandia's testing and evaluation of the first-generation units were incorporated into the designs of two improved 50-m^2 mirror modules. The results of Sandia's evaluation show significant improvement in optical performance over the first-generation designs, especially in windy conditions. 22 refs., 29 figs.

27860 Renewable energy: A global option for global warning. Eager, W. (Solar Energy Research Institute, Golden, CO (USA)). *Solar Today (USA)*, 3(6): 17-20 (Nov-Dec 1989).

Renewable-energy technologies can help dampen, and perhaps reverse, the menace of global-warming. In a report to the Congress, the U.S. Environmental Protection Agency recommended that renewable energy fulfill that promise. Some energy consultants say that the world's climate can be stabilized only if the global use of renewable energy increase from 7% (1985 figure) to 40% by the year 2025 and 53% by the year 2050. They also believe that renewable energy will be cost-competitive with traditional forms of energy by 2000. These same consultants stress the need to quickly mainstream renewable technologies into the world's energy economy. Today, the U.S. leads the world in the development of technological solutions to global warming. Briefly described are several renewable-energy systems.

27861 Support and maneuvering apparatus for solar energy receivers. Murphy, L.M. To Dept. of Energy, Washington, DC. USA Patent 4875467/A/. 24 Oct 1989. Filed date 28 Jul 1988. USA Patent Application 7-225,444. Int. Cl. F24J 2/38. 12p.

This paper describes a support and maneuvering apparatus for a solar energy receiving device adapted for receiving and concentrating solar energy and having a central axis extending through the center thereof. The apparatus includes a frame for mounting the perimeter of the solar energy receiving device. A support member extends along the central axis of the receiving device and has a base end passing through the center of the receiving device and an outer distal end adapted for carrying a solar energy receiving and conversion mechanism. A variable tension mechanism interconnects the support member with the frame to provide stiffening for the support member and the frame and to assist in the alignment of the frame to optimize the optical efficiency of the solar energy receiving device. A rotatable base is provided, and connecting members extend from the base for pivotable attachment of the frame at spaced positions therealong. An elevation assembly is connected to the receiving device for selectively pivoting the receiving device about an axis defined between the attachment positions of the connecting members on the frame.

1408 Ocean Energy Systems

Refer also to citation(s) 27860, 28122

27862 (DOE/CH/10093–66) **Ocean energy program summary: Volume 1, Overview, fiscal year 1989.** Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 15p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009481. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The oceans are the world's largest solar energy collector and storage system. Covering 71% of the earth's surface, they collect and store this energy as waves, currents, and thermal and salinity gradients. The purpose of the US Department of Energy's (DOE) Ocean Energy Technology (OET) Program is to develop techniques that harness this ocean energy cost-effectively and in a way that does not harm the environment. The program seeks to develop ocean energy technology to a point where industry can accurately assess whether the technology is a viable energy conversion alternative, or supplement, to current power-generating systems. In past studies, DOE identified ocean thermal energy conversion (OTEC), which uses the temperature difference between warm surface water and cold deep water, as the most promising of the ocean energy technologies. As a result, the OET Program is concentrating on research that advances the OTEC technology. The program also continues to monitor and study developments in wave energy, ocean current, and salinity gradient concepts; but it is not actively developing these technologies now. 13 figs.

1409 Solar Thermal Utilization

Refer also to citation(s) 28235, 28236, 28237, 28239, 28240, 28241, 28242, 28243, 28244, 28245, 28246

27863 (BFR-R–70-1989) **Solar heating system with short-term storage.** Larsson, R. (Statens Provningsanstalt, Boraas (Sweden)); Lagerkvist, K.O. Swedish Council for Building Research, Stockholm (Sweden). 1989. 70p. (In Swedish). Project BFR-860053-2. Order Number DE90770868. Available from NTIS (US Sales Only), PC A04/MF A01.

The report presents measurements and evaluation of thermal performance of a solar heating plant for preheating hot tap water for a hotel building. The total area, 120 m^2, comprises 6 parallel groups of solar collectors with 10 collectors in series. The solar energy collected is stored in 16 tanks outside the building ground floor in a rock cavern. The total storage volume is 7200 l. The storage is connected in four groups of 4 tanks each. The hot water reservoir in each tank has a volume of 0.1 m^3. A microprocessor controls the solar heat loading of the accumulator groups. During the measuring period July 1987 to June 1988 the solar heating plant collected 475 kWh/m^2 with a system efficiency of ca 50%. The solar heating system supplied 43.3 MWh of the energy demand for hot water heating i.e. 43%. The solar heating plant worked satisfactory during the entire measuring period with no operation distrubances affecting the hot water demand. (42 figs., 17 tabs.).

27864 (IBP-WB–37/1988) **Passive utilization of solar energy in owner-occupied private homes - results of measurements and energy analysis of the solar house in Zirndorf-Weiherhof.** IRB-Forschungsbericht. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 22 Sep 1988. 43p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

The aim of a project sponsored by the Federal Ministry for Research and Technology is to demonstrate how modern technology and construction concepts available on the market can be used to reduce the consumption of heating energy considerably. For this purpose 22 so-called solar houses, designed according to the principle of energy-saving construction and three conventional reference houses were built and subjected to detailed measurements. This report contains the results of the energy assessment of the solar house in Zirndorf-Weiherhof. (orig./KW) With 4 tabs., 13 figs.

27865 (IBP-WB–38/1988) **Passive utilization of solar energy in owner-occupied private homes - results of measurements and energy analysis of the solar house in Darmstadt.** IRB-Forschungsbericht. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 21 Nov 1988. 51p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

A demonstration project sponsored by the Federal Ministry for Research and Technology aims at showing how modern technology and construction concepts which are available on the market can be used to reduce the consumption of heating energy in private homes. 22 so-called solar houses, designed according to the principle of energy-saving construction and 3 conventionally built reference houses were subjected to detailed measurements. This report contains the results of the energy assessment of the solar house in Darmstadt. (orig./KW) With 10 tabs., 16 figs.

27866 (IBP-WB–46/1989) **Green solar architecture. Results of measurements and energy analysis of two solar houses in Tuebingen.** Oswald, D.; Erhorn, H. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 5 May 1989. 24p. (In German). Contract BMFT 03E-8022-A. Available from Copy held by UB/TIB Hannover.

This project tries to demonstrate how heating energy consumption in private homes can be reduced by using passive solar architecture. This report contains the results of the energy evaluation of the solar houses in Tuebingen. The studies show the influence of the building, the occupants and the heating system on the consumption of energy for heating purposes. (orig./KW) With 8 tabs., 15 figs.

27867 (SA–CE02891) **Solar hot water heating at Fir Park Village Intermediate Care Home, Port Alberni, B.C.** Traynor, J. Spearing (D.N.) and Associates, Manaimo, BC (Canada). [1984]. VP (CE–02891). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

An active solar water preheating system was installed in mid-1982 at Fir Park Village Intermediate Care Home in Port Alberni, Vancouver Island, B.C. The performance of the system was monitored, using Rho Sigma BTU meters, pyranometer, kilowatt-hour meters and thermometers. The first year's results are presented here. The system preheats water for domestic usage and the spa pool. It replaces electricity, which is subject to rationing on Vancouver Island. The installation is a Solarsystems Industries drainback type, consisting of 125 square metres (net) of collectors with single low-iron glazing and copper absorber plates with selective surface. The storage capacity of the solar tank is 9,600 litres. The design,

manufacture and installation of the system was all done by southwestern British Columbia manpower. The solar installation supplied 22.1% of the applicable domestic hot water and spa energy needs over the one-year monitoring period, saving 16,925 kWh of electricity. 11.4% of the available solar energy was delivered by the solar installation. The performance would have been considerably better if the system had not encountered operating problems during the May through September period, the period of highest insolation. The actual performance may be as much as 40% better than the measured performance, because of inherent inaccuracy of the BTU meters. Post construction servicing and problem-solving by the supplier was of long duration, resulting in a four month period when the system was totally out of operation. The system saved $780 in electricity during the first year of operation, compared to its capital cost of $83,780. 4 figs., 2 tabs.

27868 **An Atrium by any other name.** Gordon, H.T. (Burt Hill Kosar Rittlemann Associastes, Washington, DC (USA)); Anderson, D.L.; Anderson, B. *Solar Today (USA)*, 3(6): 16, 28 (Nov-Dec 1989). (CONF-890610–: American Solar Energy Society annual meeting, Denver, CO (USA), 19-23 Jun 1989).

Definitions for atria design which will help unify energy-related research and design decision-making are presented. Elements of design related to energy use are discussed in detail. Many of the definitions can be used for sunspaces.

1410 Solar Collectors and Concentrators

Refer also to citation(s) 27852, 27853, 27859, 27861

27869 (SP–1988-46) **Testing of solar heated systems and components, part 2: Compilation of test results of solar collector testing Jul 1986 to Dec 1987.** Bergquist, P. Statens Provningsanstalt, Boraas (Sweden). 1989. 39p. (In Swedish). Project BFR-860647-6. Order Number DE90770872. Available from NTIS (US Sales Only), PC A03/MF A01.

This report contains test results for six solar collectors manufactured in Sweden, of which five are water cooled and one is an air collector. All official solar collector tests in Sweden are carried out by the Swedish National Testing Institute (NTI). Two of the collectors reported now have been tested for marketing in the USA, in accordance with the methods and procedures as laid down by the Solar Rating and Certification Corporation (SRCC), USA. In this report the results from those tests are summarized for the collectors Sun Star 91-Aqua P and Sun Star 91-Air P. The report also contains a summarizing comparison of the procedures used in solar collector testing in the United States and in Sweden. During the above period, only thermal efficiency tests have been carried out at NTI, using both solar simulator and outdoor tests. For two modified collector types, the measurements revealed temporary problems in the process of applying the selective absorber layer, leading to optical efficiencies far below expected values. For one of these collectors the test was interrupted and is not reported here. Solar collectors tested 1985 to June 1986 now show better thermal performance than a calculated 'mean collector' from that period. The results for each collector are given in a condensed form on two sheets, including plots of thermal efficiency, heat loss coefficients and heat losses as functions of mean fluid temperature above ambient. Measurements on an unglazed solar collector have been incorporated in the project. The aim was to evaluate a thermal performance model for unglazed collectors. It was part of a Swedish contribution to the IEA, task 3 work. Only the conclusions are given in English.

15 GEOTHERMAL ENERGY

Refer also to citation(s) 27860

1501 Resources and Availability

27870 (DOE/CH/10093–71) **Geothermal energy program summary: Volume 2, Research summaries, fiscal year 1989.** Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 70p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009486. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Geothermal Technology Division (GTD) of the US Department of Energy (DOE) is charged with the lead federal role in the research and development (R&D) of technologies that will assist industry in economically exploiting the nation's vast geothermal resources. The GTD R&D Program represents a comprehensive, balanced approach to establishing all forms of geothermal energy as significant contributors to the nation's energy supply. It is structured both to maintain momentum in the growth of the existing hydrothermal industry and to develop long-term options offering the greatest promise for practical applications. This volume, Volume 2, contains a detailed compilation of each GTD-funded R&D activity performed by national laboratories or under contract to industrial, academic, and nonprofit research institutions.

1503 Geothermal Exploration and Exploration Technology

27871 (RISO-M–2674) **The temperature field around hot magma sheets.** Klint Jensen, P. Risoe National Lab., Roskilde (Denmark). Energy Technology. Nov 1989. 17p. Order Number DE90770669. Available from NTIS (US Sales Only), PC A03/MF A01.

The transient temperature field around hot horizontal magma sheets (sills) has been calculated. The finite difference technique has been used. Comparison of the results of numerical and analytical calculations shows good agreement. It is assumed that transportation of heat is conductive. Convection is neglected. The latent heat of the minerals is taken into account. Three cases with the sill at different depths are studied. In one case the sill is at the surface. It is demonstrated that cooling of the sills is strongly depending on the sedimentary cover. (author) 6 ills., 3 refs.

27872 (STEV-GT–89-2) **Recovery of geothermal energy from weak stones in rocks, stage 4.** Linden, A.H. (Sveriges Geologiska AB, Uppsala (SE)); Windelhed, K. Sveriges Geologiska AB, Uppsala (Sweden); Statens Energiverk, Stockholm (Sweden). Aug 1989. 66p. (In Swedish). Project STEV-411-313. (IRAP–89622). Order Number DE90770770. Available from NTIS (US Sales Only), PC A04/MF A01.

The report presents activities and results from stage 4 in project Crushed Zones. The general object has been to evaluate the technical possibilities energy recovery from water-canying crushed zones. Out of depths of 200 m and more water is pumped the heat energy being directly on indirectly utilized. A high water flowrate combined with as high temperature as possible are the most important parameters. The price of energy from a plant using water from crushed zones depends on how accurate available temperature and flowrate can be estimated. With the resources available today the temperature will be relatively well predictied. Good methods of quantitying available flowrate is however lackering. Fractured zones may be located but they does not need to be water-carrying. A possibility of better judgement of this might be to measure the ground water helium contents. The method is however not completely developed. With the methods available the energy price would be 0.30-0.50 SEK/kWh in a plant using water form a 200-500 m deep fractured zone. Large plants will be more economic. Continued development effects would probably lead to additional cost reductions. Direct utilization of the energy, without heat pump, will also result in a lower energy price.

1505 Economic, Industrial, and Business Aspects

Refer also to citation(s) 27870, 27872, 28122

27873 (DOE/CH/10093–70) **Geothermal energy program summary: Volume 1, Overview, fiscal year 1989.** Solar Energy Research Inst., Golden, CO (USA). Jan 1990. 20p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009485. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document reviews Geothermal Energy Technology and the steps necessary to place it into service. Specific topics covered are: four types of geothermal resources; putting the resource to

work; power generation; FY 1989 accomplishments; hard rock penetration; conversion technology; and geopressured brine research. 16 figs. (FSD)

1508 Geothermal Power Plants

Refer also to citation(s) 27873

1509 Geothermal Engineering

Refer also to citation(s) 27870, 27873

27874 (SAND–89-0790) **Laboratory and field evaluation of a two-component polyurethane foam for lost circulation control.** Loeppke, G.E. (Sandia National Labs., Albuquerque, NM (USA)); Glowka, D.A.; Rand, P.B.; Jacobson, R.D.; Wright, E.K. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 104p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. Order Number DE90010241. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

A two-part polyurethane foam supplied by Poly Plug, Inc., has been tested in the laboratory and in the field to assess its utility in controlling lost circulation encountered when drilling geothermal wells. A field in The Geysers was conducted, based on earlier laboratory work that showed the foam chemical formulation to be capable of expanding under elevated temperatures and pressures to form a rigid, impermeable polymer that should be effective in plugging fluid-loss zones. Although the downhole tool used to deploy the foam chemicals apparently functioned properly in the field test, the chemicals failed to expand significantly downhole, instead forming a dense polymer that may be ineffective in flowing into and sealing loss zones. Subsequent laboratory tests were conducted under simulated downhole conditions to determine the cause of the polymer's failure to sufficiently expand. The results indicate that the foam chemicals undergo vigorous mixing with water in the wellbore, which disturbs the kinetics of the chemical reaction more than was previously contemplated. The results indicate that without significant changes in the foam chemical formulation or delivery technique, the existing foam system will be ineffective in lost circulation control except under very favorable conditions. 6 refs., 46 figs., 7 tabs.

1520 Geothermal Data and Theory

27875 (LA-UR–90-505) **The pressure dilation of a deep, jointed region of the earth.** Brown, D.W.; Robinson, B.A. Los Alamos National Lab., NM (USA). [1990]. 8p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-36. (CONF-900640–3: International conference on rock joints, Loen (Norway), 4-6 Jun 1990). Order Number DE90007537. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A series of pressurization tests of a 3.5-km deep body of jointed crystalline rock has shown that both the pressure deformation (i.e., dilation) of the region and the boundary permeation are nonlinear functions of the effective stress. This is because the apertures for both the joints and microcracks are strong functions of the effective normal stress acting to close them. For a surface pressure increase from zero to 7.5 MPa, the fluid storage in the natural joints and microcracks in this 0.3 km^3 volume of rock increased by 1470 m^3. The corresponding increase in fluid storage between 7.5 and 15 MPa was 1090 m^3. However, even at a surface pressure level of 15 MPa, the permeation loss rate from this large volume of rock is only 0.3 l/s after six months of pressure maintenance. Using transient nonlinear numerical modeling, it is shown that the pressure-dependent fracture permeability model of Gangi, and the fracture porosity equivalent, adequately represent the measured permeability and porosity data obtained to date from this continuing series of pressurization experiments.

17 WIND ENERGY

Refer also to citation(s) 27860

1701 Resources and Availability (Climatology)

27876 (DOE/BP/63406–1) **Analysis of extreme winds at Pacific Northwest wind energy survey sites.** Wade, J.E.; Wittrup, R.J. Oregon State Univ., Corvallis, OR (USA). Wind Resources Assessment Lab. Sep 1987. 137p. Sponsored by U.S. DOE Management & Administration. DOE Contract BI79-86BP63406. (BPA–87-24). Order Number DE90009461. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The purpose of this report is to examine extreme winds at wind energy survey sites in the Pacific Northwest and to forecast future extremes. Additionally this report reviews previous estimates of extreme winds in the Pacific Northwest and evaluates available statistical approaches to extreme wind estimates. A review of the literature on wind indicated the most widely used extreme wind statistic is the one minute mean fastest wind speed. However, in this study the data that were available for use were hourly average extreme winds and peak 2 second gusts or instantaneous gusts. This information was collected as part of Bonneville Power Administrations Wind Energy Resource Assessment Program. Among the problems encountered in extreme wind estimation is the lack of long term continuous, uniform data sets. Frequent changes in anemometer height and location have plagued analysis of extreme winds. Conventional methods of estimating extreme winds requires data collected over 20 to 30 years. However in this study, data records seldom exceed two to three years and the longest are only 10 years. Different averaging times and data collection techniques have been noted as significant obstacles to uniform data sets. Another significant problem with many data sets is the problem of the dynamic range of the measuring instrument being insufficient to record the strongest winds. 45 refs., 32 figs., 23 tabs.

27877 (DOE/BP/63406–9) **Wind forecasting for utility operations: Final report.** Wade, J.E. (Oregon State Univ., Corvallis, OR (USA). Energy Resources Research Lab.); Baker, R.W.; Walker, S.N. USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Resource Management; Oregon State Univ., Corvallis, OR (USA). Energy Resources Research Lab. Feb 1990. 62p. Sponsored by U.S. DOE Management & Administration. DOE Contract BI79-86BP63406. (BPA–89-30). Order Number DE90009466. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Winds are an important climatic variable in utility operational planning. Light winds reduce air quality, severe winds represent a threat to structures, and dispatchers must know the wind speed if wind energy conversion facility output is to be anticipated. This report examines two wind forecasting problems: forecasting wind energy output and forecasting extremely strong winds. Utilities have long used weather forecasts in making load projections. However, the problem of forecasting wind energy availability presents a new challenge. Wind is one of the hardest weather variables to forecast. In addition, the wind turbine's response to variations in the wind is very nonlinear. To be useful, studies have shown that wind forecasts must be accurate to within 2 mph. The current "state of the art" appears to be a forecasting error of about 3 mph. 16 refs., 37 figs., 9 tabs.

27878 (STEV-VIND–90-1) **Increased fatigue loading at the Naesudden wind turbine in connection with organized wind-structures.** Smedman, A.S. Statens Energiverk, Stockholm (Sweden). Feb 1989. 41p. Project STEV-506-226. Order Number DE90770851. Available from NTIS (US Sales Only), PC A03/MF A01.

Meteorological measurements taken at the Naesudden wind turbine site during slightly unstable condition have been analyzed. The height of the convective boundary layer is rather low and is found to vary between 60 m and 300 m. Turbulence statistics near the ground follow Monin-Obukhov similarity, whereas the rest of the boundary layer can be treated as a 'near neutral upper layer'. In 60% of the runs horizontal roll vortices are found. Spectra and co-spectra are used to identify the structures. Those organized structures have time scales which are long compared to the rotational speed of the blades. Thus the turbulence is perfectly correlated over the turbine disc, which will create a periodic loading at the rotational frequency. This loading adds to the loading of wind shear and gravity. (author).

1705 Environmental Aspects

Refer also to citation(s) 28996

1706 Wind Energy Engineering

Refer also to citation(s) 27876, 27877, 28191

27879 (DOE/BP/63406–6) **Regional wind energy assessment: Progress report, June 1987–May 1988.** Wade, J.E. (Oregon State Univ., Corvallis, OR (USA). Wind Resources Assessment Lab.); Walker, S. USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Resource Management; Oregon State Univ., Corvallis, OR (USA). Wind Resources Assessment Lab. Feb 1990. 146p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract BI79-86BP63406. (BPA–88-28). Order Number DE90009380. Available from NTIS, PC A07/MF A01 - OSTI.

The purpose of this report is to discuss the status of Bonneville Power Administrations wind monitoring program and the data collected from 1987 through May 1988. The wind monitoring program has been on-going since 1976. The annual summary of this data provides BPA with a periodic status report on both the equipment and wind resource being measured. There were 12 active sites this year. Three sites were instrumented at more than one level and one site, Cape Blanco, had anemometers at two different locations. The second Cape Blanco anemometer was taken out in January and the Albion Butte site failed in February and was removed in July of 1988. The data recovery rate for all sites this past year was 80%. Two sites were inactive for half the year, Albion Butte and Spring Creek. The Spring Creek site experienced reoccurring failure of the data logger cassette interface. Pequop Summit and Upper Pyle also had low data rates because of problems with the cassette tape reader. For each site data are summarized for the entire period of record in the report's Appendices. For three sites there are 12 years of record. These summaries provide the most important wind speed statistics required by potential wind developers. In addition, the appendices contain pressure and temperature data for each site. 2 refs., 12 figs., 22 tabs.

27880 (DOE/BP/63406–12) **Regional wind energy assessment progress report, June 1988–May 1989: Final report.** Wade, J.E.; Baker, R.W.; Walker, S.N. Oregon State Univ., Corvallis, OR (USA). Wind Resources Assessment Lab. Oct 1989. 111p. Sponsored by U.S. DOE Management & Administration. DOE Contract BI79-86BP63406. (BPA–89-33). Order Number DE90009439. Available from NTIS, PC A06/MF A01 - OSTI.

The purpose of this report is to discuss the status of Bonneville Power Administrations wind monitoring program and the data collected from June 1988 through May 1989. The wind monitoring program has been on-going since 1976. The annual summary of this data provides BPA with a periodic status report on both the equipment and wind resonance being measured. There were nine active sites this year. Three sites were instrumented at more than one level. One site, Hampton Butte, apparently failed in November of 1988 and was removed in May of 1989. The data recovery rate for all nine sites over their entire period of record was 82%. For each site, data are summarized for the past year in the body of the report. The statistics used to characterize the wind resource include: mean wind speed; peak gust; available energy; Weibull parameters; available energy; data recovery rate; and estimated turbine energy output for eight selected wind turbines. The appendices include summarized data for the entire period of record at these sites. These summaries provide the most important wind speed statistics required by potential wind developers. 8 refs., 29 figs., 18 tabs.

27881 (RISO-M–2814) **Panel method, computer model of a flow around a profile.** Christensen, H.F.; Aagaard Madsen, H. Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Oct 1989. 30p. (In Danish). Contract EN3W/C1/166/DK. Order Number DE90770668. Available from NTIS (US Sales Only), PC A03/MF A01.

This report is made in connection with the HAWT project and contains a valuation on the following issues: - Use of a method to correct the locally measured flow velocity in front of a LM 8,5 m wing such as to determine the free flow velocity. - Comparison of the actual LM 8,5 m wing and theoretical data from the NACA 63n-200 series. In combination with the first topic a computer code, which make use of a vortex-panel method to calculate flow parameters, is developed. The code is at first tested on a Zukovsky profile with a known Cp-curve. This initial test is made to give an estimate of: - How the result in influenced by the number of panels chosen. - How the result is influenced by the way one place the panels if the number of panels is constant. (author) 21 ills., 6 refs.

27882 (RISO-M–2815) **Function testing of the test turbine on The Test Station for Wind Turbines.** Voelund, P.; Kretz, A. Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Oct 1989. 38p. (In Danish). Order Number DE90770671. Available from NTIS (US Sales Only), PC A03/MF A01.

The test turbine on The Test Station is constructed with the purpose of enabling measurements and tests, that cannot be carried out on Danish standard wind turbines. It is equipped with metering stays, that makes it possible directly to measure rotor-thrust, sidewards force on the rotor, yawing moment on rotor, rotor torque, nacelle tilting moment and nacelle yawing moment. A function testing of the turbine, that includes power-curve, eigenfrequencies and efficiency of mechanical brake is reported. A list of the most important technical data and a few technical drawings are reported. A finite element model of the test turbine, that has been build up and adjusted to the reported measurements, is also reported. The test turbine and the finite element model are ready for use in tests. (author) 5 tabs., 27 ills.

27883 (RISO-M–2824) **Contributions from the Department of Meteorology and Wind Energy to the EWEC '89 Conference in Glasgow, UK.** Hauge Madsen, P. (ed.). Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Oct 1989. 58p. (CONF-890717–Exc.: EWEC '89: European wind energy conference and exhibition, Glasgow (UK), 10-13 Jul 1989). Order Number DE90770672. Available from NTIS (US Sales Only), PC A04/MF A01.

The participants of the Department of Meteorology and Wind Energy in the 1989 European Wind Energy Conference and Exhibition (EWEC) 10-13 July 1989, Glasgow, UK involved the presentation of 9 papers and posters by members of the department as author and coauthors. The papers give a presentation of recent results of the departments wind energy activities. This report gives the full set of papers and posters. 13 tabs., 80 ills., 80 refs.

27884 (RISO-M–2824, pp. 7-12) **Aerodynamics of a full-scale, non rotating wind turbine blade under natural wind conditions.** Paulsen, U.S. (The Test Station for Windmills, National Laboratory Risoe, Rokilde (DK)). Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Oct 1989. (CONF-890717–Exc.: EWEC '89: European wind energy conference and exhibition, Glasgow (UK), 10-13 Jul 1989). In *Contributions from the department of meteorology and wind energy to the EWEC'89 conference in Glasgow, UK.* Order Number DE90770672. Available from NTIS (US Sales Only), PC A04/MF A01.

Experiments on aerodynamic behavior are carried out under natural wind conditions on a full-scale NACA 44XX series airfoil blade, with a 6.4 m span and a linear variation of taper, thickness and geometrical twist. The blade is mounted vertically on a 12 m high tower on a moment balance, which measures bending moments in two directions perpendicular to each other. Bending moments are analyzed in directions parallel and perpendicular to the onset flow and to the chord at the tipsection, and results are compared with different theoretical models using two-dimensional airfoil-section characteristcs gathered from wind tunnel (WET) tests. The obtained chord Reynolds Number (Re) ranges between 500,000 and 1,000,000, and the influence on the aerodynamic characteristics is discussed. The onset flow is measured 2 m in front of the blade, at a height of approx. 15.8 m above ground level. The comparison show significant deviations on drag and lift effects for the blade considered. The main deviation between airfoil characteristcs measured in natural wind and those obtained from WT measurements are found in the region where stall occurs. The particular measurements demonstrate at angles of attack after stall that more lift and less drag can be achieved than under WT test conditions. The airfoil-characteristics are analyzed through parameters describing variations governed by shifts in wind-direction and wind speed, and

through the blade bending motion. From these data, conclusions are made illustrating the relative importance of instationary effects originating from turbulence, hysteresis and three-dimensional flow around the blade. The findings are discussed relative to wind turbine application, considering a 55 kW rotor using a blade of the present type. (author) 11 refs.

27885 (RISO-M–2824, pp. 13-17) **An experimental investigation of flap-wise blade-root load spectra for fatigue lifetime estimation.** Andersen, P.D. (Risoe National Laboratory, Roskilde (DK)); Petersen, S.M. Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Oct 1989. (CONF-890717–Exc.: EWEC '89: European wind energy conference and exhibition, Glasgow (UK), 10-13 Jul 1989). In *Contributions from the department of meteorology and wind energy to the EWEC'89 conference in Glasgow, UK.* Order Number DE90770672. Available from NTIS (US Sales Only), PC A04/MF A01.

The aim of this paper is to examine fatigue load distributions for flap wise blade root bending moment in order to determine the influence from wind speed, turbulence intensity and yaw error on the range distribution. Two Vestas wind turbines are examined: A Vestas V25, and a Vestas V20. A computer code has been established to: - extrapolate measured 10 minutes fatigue load distribtuions at low wind speeds where measurements often are hard to get. - extrapolate measured 10 minutes fatigue load distributions to a life-time distribution. - estimate an equivalent constant amplitude (width) load range, and a relative life-time consumption - based on the life-time fatigue load distribution. The paper concludes that extrapolation of series of 10 minutes fatigue load distributions to a life-time distribution can be done with some limitations. The significant influences on fatigue loads from turbulence and yaw error are demonstrated. Especially for the V25 machine this influence is distinct. For a Danish site a yaw error of -5 deg will result in a decrease in life-time of near 50%. (author).

27886 (RISO-M–2824, pp. 18-22) **An intercomparison of models for wind flow in complex terrain and data from the Blashaval experiment.** Walmsley, J.L. (Atmospheric Environment Service (CA)); Troen, I.; Lalas, E.P.; Mason, P.J. Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Oct 1989. (CONF-890717–Exc.: EWEC '89: European wind energy conference and exhibition, Glasgow (UK), 10-13 Jul 1989). In *Contributions from the department of meteorology and wind energy to the EWEC'89 conference in Glasgow, UK.* Order Number DE90770672. Available from NTIS (US Sales Only), PC A04/MF A01.

A Workshop on Modelling of the Atmospheric Flow Field was held at the International Centre for Theoretical Physics in Trieste, Italy in May 1988. The authors conducted lectures, presented models and undertook an intercomparison of the model results in an application to Blashaval Hill. It was agreed that we would repeat this experiment on a formal basis, ensuring that all models began with the same topographic input data. This paper presents the results of that study. (author) 11 refs.

27887 (RISO-M–2824, pp. 23-29) **Optimization of power output from wind turbines.** Frandsen, S. (Department of Meteorology and Wind Energy, Risoe National Lab., Roskilde (DK)); Hauge Madsen, P. Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Oct 1989. (CONF-890717–Exc.: EWEC '89: European wind energy conference and exhibition, Glasgow (UK), 10-13 Jul 1989). In *Contributions from the department of meteorology and wind energy to the EWEC'89 conference in Glasgow, UK.* Order Number DE90770672. Available from NTIS (US Sales Only), PC A04/MF A01.

In high-wind climates, the standard wind turbine is not optimized relative to the wind speed distribution, i.e. the machine extracts a lower fraction of the energy available in the wind than theoretically possible. It is demonstrated by an example that the over-all efficiency may be as low as 15% while under other circumstances a modern wind turbine is expected to utilize more than 30% of the wind energy. Thus, for the same external geometry of the wind turbine, the output may be doubled. The basic mean to increase the over-all efficiency in high-wind speed climates is to increase the rpm of the machine (the present trend in wind turbine optimization is actually the opposite: increasing the swept area by means of blade extenders together with decreased rpm). For stall regulated machines, the consequences of increased rpm include higher rated power and larger aerodynamic loads. The paper analyses the technical impact in terms of increase in materials' consumption and briefly indicates the economic benefits obtained by the suggested improvement of efficiency. The potential cost effectiveness is found to be significant. (author).

27888 (RISO-M–2824, pp. 39-44) **Rotor loading on a three-bladed wind turbine.** Hauge Madsen, P. (Risoe National Laboratory, Roskilde (DK)); Rasmussen, F. Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Oct 1989. (CONF-890717–Exc.: EWEC '89: European wind energy conference and exhibition, Glasgow (UK), 10-13 Jul 1989). In *Contributions from the department of meteorology and wind energy to the EWEC'89 conference in Glasgow, UK.* Order Number DE90770672. Available from NTIS (US Sales Only), PC A04/MF A01.

For a well designed and adjusted horizontal axis wind turbine the turbulence in the wind is one of the primary sources of cyclic loading. Wind turbulence not only caused blade loads, but is responsible for the major part of the cyclic rotor loads which are transferred through the rotor shaft. In order to predict the cyclic part of the primary structural rotor loads, the thrust, the yaw and the tilt moment, a model has been developed. The model works in the frequency domain and uses the standard engineering representation of turbulence in terms of a coherence function and a power spectrum. The model which accounts for the rotational sampling of the turbulent wind field, shows good agreement with the results of testing programmes on wind turbines which are tested at The Test Station for Windmills at Risoe National Laboratory. The comparison is made in terms of both the frequency content of the turbulence induced loads as well as of the associated fatigue damage. A parametric study demonstrates the effect of the tower bending and tower torsion flexibility on the magnitude of the cyclic rotor loads. (author).

27889 (RISO-M–2824, pp. 45-53) **Testing and modelling at Riso National Laboratory of the Chalmers 22/18 kW wind/diesel system.** Christensen, C.J. (Department of Meteorology and Wind Energy, Risoe National Laboratory, Roskilde (DK)); Lundsager, P. Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Oct 1989. (CONF-890717–Exc.: EWEC '89: European wind energy conference and exhibition, Glasgow (UK), 10-13 Jul 1989). In *Contributions from the department of meteorology and wind energy to the EWEC'89 conference in Glasgow, UK.* Order Number DE90770672. Available from NTIS (US Sales Only), PC A04/MF A01.

As part of a joint Riso/Chalmers project, the Chalmers 22/18 kW wind/diesel system has been tested at Riso. The paper presents results from a series of measurements in the spring of 1989 and discusses the results concerning overall system behaviour, power quality and fuel savings. By computer simulation of the system and some alternatives where the wind turbine is connected directly to the bus bar, the influence of a number of design features on system performance is discussed. (author).

27890 (RISO-M–2824, pp. 54-60) **Visualization of flow through a stall-regulated wind turbine rotor.** Pedersen, T.F. (The Test Station for Windmills, Risoe National Laboratory (DK)); Antoniou, I. Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Oct 1989. (CONF-890717–Exc.: EWEC '89: European wind energy conference and exhibition, Glasgow (UK), 10-13 Jul 1989). In *Contributions from the department of meteorology and wind energy to the EWEC'89 conference in Glasgow, UK.* Order Number DE90770672. Available from NTIS (US Sales Only), PC A04/MF A01.

This paper presents flow-visualization studies conducted on upwind, stall-regulated wind turbines. The objective was the determination of the characteristics of the general flow patterns around and in the wake of the turbines. For this purpose smoke was emitted from smoke-grenades either attached on the trailing edge of a blade - at different spanwise positions - or mounted on a mast placed upwind of the rotor at hub height. The tests covered a spectrum of different wind speeds-corresponding to different rotor conditions (heavily loaded rotor, optimum Cp, stall conditions). The

flow patterns were recorded using video (CCD) and 35 mm photographic cameras. The observations discussed in this paper are: the formation and features of the tip vortices, the roll-up of the vortex sheet, the expansion of the wake and the downwind speeds inside it and the rotor- tower interference effects. (author) 12 refs.

27891 (SV-UL–1989-47) **Evaluation of location program WAsP from Risoe.** Tunell, G. Swedish State Power Board, Vaellingby (Sweden). 12 Oct 1989. 36p. (In Swedish). Order Number DE90770780. Available from NTIS (US Sales Only), PC A03/MF A01.

The program estimates wind supply at arbitrang sites starting out from measured wind supply in neighbouring measuring masts. Measured wind speeds at four masts on Gotland were used in a number of calculations where comparisons were made between calculated and measured data. Calculations show that wind data from long-term measurements at airfields and simple wind measurements yield calculation errors of nearly 10% in wind speed and almost 25% in energy production. With better wind data the error may be halved. If the distance from the measuring mast is long and one proceeds from coast to inland the error in energy production may be as high as 50%. Misjudgements also increase in broken ground. This fact does not only point out weaknesses in the model but also strong variations in wind supply. To reduce these errors short measuring campaigns (c:a 12 months) are needed at possible location sites. The measured data could then also be used for calibration of the calcultaion model. (7 tabs., 14 refs.).

1707 Health and Safety

Refer also to citation(s) 27883

27892 (RISO-M–2824, pp. 30-34) **Recommendations for an European wind turbine safety standard and load cases standard made by the cooperation of the European Wind Energy Test Sites.** Hjuler Jensen, P. (The Test Station for Windmills, Risoe National Laboratory, Roskilde (DK)). Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Oct 1989. (CONF-890717–Exc.: EWEC '89: European wind energy conference and exhibition, Glasgow (UK), 10-13 Jul 1989). In *Contributions from the department of meteorology and wind energy to the EWEC'89 conference in Glasgow, UK.* Order Number DE90770672. Available from NTIS (US Sales Only), PC A04/MF A01.

The paper outlines the efforts made by The Commission of the European Communities and the cooperation of The Test Station for Wind Turbines in Europe to establish European standards for wind turbines. The final goal is to achieve an open marked for wind turbines within the European community. The Test Stations make within the cooperation recommendations for standardization in different technical fields. The recommendation for a safety standard is outlined in the paper and the status for the work on the recommendation for a load case standard is given. (author).

27893 (RISO-M–2824, pp. 35-38) **Recommendations for a European wind turbine standard on performance determination.** Curvers, A.P.W.M. (Netherlands Energy Research Foundation ECN, Petten (NL)); Pedersen, T.F. Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Oct 1989. (CONF-890717–Exc.: EWEC '89: European wind energy conference and exhibition, Glasgow (UK), 10-13 Jul 1989). In *Contributions from the department of meteorology and wind energy to the EWEC'89 conference in Glasgow, UK.* Order Number DE90770672. Available from NTIS (US Sales Only), PC A04/MF A01.

Within the framework of a uniform development of licensing criteria and certification procedures for wind turbines within the European Communities, CEC has commissioned a contract to a group of European Wind Turbine Test Stations (ECN, RISOE, CWD, NEL, VUB, WISA) to set-up a set of recommendations for a European Wind Turbine Standard on Performance Determination. The present recommendations are based on the established experiences of the Test Stations involved, on existing standards (IEA, AWEA, CSA) and on a CEC study on accuracy of power curve measurements. In comparison with the existing standards the most important differences are: 1. The total measurement time is proposed to be dependent on a minimum number of data sets per bin and a 1% statistical uncertainty in the annual energy output due to wind variability. 2. The required accuracies of the measurement instrumentation and signal conditioning have been strengthened. 3. It has been recommended to apply different correction procedures on air density variation, for stall regulated and pitch regulated wind turbines. 4. The analyses of instrument uncertainties and statistical error due to wind variability have been adopted in the recommendations. The testing procedure has been adjusted to the above mentioned changes. (author) 15 refs.

20 FOSSIL-FUELED POWER PLANTS

Refer also to citation(s) 28151, 28152

27894 (NEI-FI–90) **Energy meeting in Middle-Finland 89.** Valtion Teknillinen Tutkimuskeskus, Jyvaeskylae (Finland). Kotimaisten Polttoaineiden Lab. 1989. 97p. (In Finnish). (CONF-8901185–: Seminar on Energy meeting in Middle-Finland '89: energy and society, Jyvaeskylae (Finland), 19 Jan 1989). Order Number DE90706084.

Individual papers are separately indexed.

27895 (ORNL/FMP–89/2, pp. 613-616) **TCRD-4 - Development of user-friendly software for the thermomechanical stress analysis of refractory systems.** Chen, Ensheng (Tennessee Center for Research and Development, Knoxville (USA)); Buyukozturk, O. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The Tennessee Center for Research and Development (TCRD), through its Thermomechanical Model Software Development Center, has formed a consortium of manufacturers and others interested in the thermomechanical stresses of refractory systems. The objective of this project is to develop a user-friendly, intelligent, computer-based software for the thermomechanical stress analysis of refractory systems that will be based on the finite-element analysis computer model developed at MIT.

2001 Power Plants and Power Generation

Refer also to citation(s) 27507, 27508, 27951, 27954, 28153, 28317, 28348, 28356, 28357, 28406, 28407

27896 (EGG-M–89435) **A strategy for RCM [Reliability-Centered Maintenance] implementation.** Purser, F.E. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-8906312–1: 17. Inter-RAM conference, Hershey, PA (USA), 12-15 Jun 1989). Order Number DE90009614. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Reliability-Centered Maintenance (RCM) is a maintenance program that prioritizes components and selects PM tasks based upon critical functions to safe plant operation and upon the dominant failure modes of the equipment needed for those critical functions. Most RCM programs to date have used prior EPRI studies and qualitative analysis as a basis for developing plant specific programs. The strategy presented in this paper is based on the above definition alone and uses quantitative then qualitative techniques that consider both failure likelihood and failure effects. This approach is being applied to reactor an process facilities at the Idaho National Engineering Laboratory. The strategy has an easily understandable followed framework which simplifies the implementation effort and is applicable to any process facility where risk and/or availability is important. The implementation framework includes the use of computer codes to prioritize equipment form both a risk and an availability perspective. A functional failure modes and effects analysis is performed for the critical components and from this the appropriate PM option and spare parts stock level is determined. A cost/benefit analysis is included in the framework and the program helps determine the PM procedures and schedule. Once a PM is performed, results are fed back into the database and the

plant model to produce a continually updated program that is both effective and applicable. 1 fig.

27897 (EPRI-GS–6699) **Guidelines for makeup water treatment: Final report.** Cline, D.A. Jr. (Powell (Sheppard T.) Associates, Baltimore, MD (USA)); Shields, K.J. Electric Power Research Inst., Palo Alto, CA (USA); Powell (Sheppard T.) Associates, Baltimore, MD (USA). c Mar 1990. 424p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The EPRI Fossil Plant Cycle Chemistry Program, RP 2712, was developed in recognition of the importance of controlling cycle water and steam purity in attainment of maximized unit availability, reliability and efficiency. This guideline characterizes the state-of-the-art technology for production of cycle makeup water. It is intended to complement other RP 2712 projects in the areas of cycle chemistry guidelines, instrumentation and control, guideline demonstration and verification, and related subject areas. This guideline reviews available technology for and preferred approaches to production of fossil plant cycle makeup from various raw water supplies. Subject areas covered include makeup water source and source characteristics, unit processes comprising makeup treatment systems, guidelines for process selection, resin and membrane selection guidelines, techniques for monitoring performance and cost effectiveness, and waste disposal considerations. The report also identifies additional research activity needed to advance the state-of-the-art for makeup water treatment, results of a utility industry survey and other related topics. 72 refs., 60 figs., 74 tabs.

27898 (LUTMDN-TMVK–5183-1-94-1989) **Steam injection in gas turbines: Heat balance calculations on a plant with internal production of distilled water.** Idh, C. Lund Univ. (Sweden). Dept. of Heat and Power Engineering. Nov 1989. 96p. (In Swedish). Order Number DE90770864. Available from NTIS (US Sales Only), PC A05/MF A01.

Examination paper.

Theoretical and experimental studies of steam or water injection in gas turbines are reported. An exponential reduction of NO_x emissions for increased steam injection is noted, but also a tendency for increased quantities of CO and unburnt hydrocarbons. The main task of the work was to make a program for heat balance calculations. A gas turbine with autonomous production of distilled water was chosen as a reference plant. The quantity of steam that is injected is limited by the capacity of production from the waste heat of the flue gas. From a parametric variation it was shown that the specific power and the efficiency increased with the quantity of steam injected. The specific power was independent of the temperature of the steam (water), but the efficiency increased with the temperature of the steam. At water injection, the efficiency is reduced except for at very high pressures.

27899 (LUTMDN-TMVK–5184-1-147-1989) **Heat balance calculations on a combined-cycle power plant with the program GTPRO.** Nilsson, Kenneth; Ottosson, Peter. Lund Univ. (Sweden). Dept. of Heat and Power Engineering. Dec 1989. 148p. (In Swedish). Order Number DE90770877. Available from NTIS (US Sales Only), PC A07/MF A01.

Examination paper.

The project is composed of a number of power plants components available in the market. In a library is stored data of a number of gas turbines. One of these is selected and coupled to a steam system. There are seven main types and a number of subtypes to chose among. When this primary laying out is finished a number of operating data is chosen, whereupon the program calculated the heat balance of the entire plant. The program is speedy and easy workable. The drawback is the lack of flexibility by the laying out. The program was used for control of some heat balances. However, the result of this work was rather that the program limitations were brought to light than a control of the heat balances. New versions of the program are currently published. The report considers versions available in Sweden up to August 1989. (52 figs., 17 tabs., 16 refs.).

27900 (NEI-FI–90, pp. 9) **Small sized power plants in production of electric power.** Mutanen, K. (Valtion Teknillinen Tutkimuskeskus, Jyvaeskylae (Finland). Polttoaine- ja Polttotekniikan Lab.); Miettinen, M. Valtion Teknillinen Tutkimuskeskus, Jyvaeskylae (Finland). Kotimaisten Polttoaineiden Lab. 1989. (In Finnish). (CONF-8901185–: Seminar on Energy meeting in Middle-Finland '89: energy and society, Jyvaeskylae (Finland), 19 Jan 1989). In *Energy meeting in Middle-Finland 89.* Order Number DE90706084. Available from NTIS (US Sales Only), PC A05/MF A01.

Combined production of heat and electricity is the most efficient fuel based method for production of electric power. The Finnish industry and also the largest cities have quite completely utilized this possibility of electric power generation. The total amount of electric power produced by this method was 13.4 TWh in the year 1987. This was approx. 24% of the total demand for electric power. The limit of profitability of combined production has been estimated to be in the case of solid fuels 30 MW of electric power. The suppliers have however developed also smaller plants (2-25 MW). Many towns and population centers have been interested in building of plant of this size. The total potential has been estimated to be in the year 2000, within power range 0.5-40 MWt, approx. 1 220 MWt, 340 MWt of which is sited along the natural gas pipeline. The possibilities to use domestic fuels lie to north of the natural gas pipeline. Only those areas in which there are district heating power plants are included in this estimation. District heating networks which are situated among industrial power plants or other larger power plant are excluded. The increase of domestic fuels would be, counted as peat in the maximum approx. 5 million m^3/a. Another estimate gives the value of 1.5 million m^3/a. Steam power plants, gas turbine plants or diesel plants would be suitable as small sized power plant on short term. The minimum power range of steam power plants is 10-15 MWt and the maximum power range of gas diesel power plants 15-20 MWt, which means that they do not compete with each other.

27901 (ORNL/FMP–89/2, pp. 37-50) **CERAMATEC-1 - Design, fabrication, and interface characterization of ceramic fiber-ceramic matrix composites.** Griffin, C.W. (Ceramatec, Inc., Salt Lake City, UT (USA)); Richerson, D.W.; Limaye, S.Y.; Shetty, D.K. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

This report describes the progress achieved on the second phase of a three-phase program to design and fabricate ceramic-fiber/ceramic matrix composites that exhibit high strength and high fracture toughness at temperature up to 1200°C in an oxidizing atmosphere. These composites are being designed by optimizing the fiber/matrix interface through characterization and control of the interfacial bond. The Phase I research established the experimental feasibility of a new modified pushout test and verified the supporting theoretical relations that permit determination of the interfacial properties including the shear debond strength, the sliding friction shear stress, the residual compressive stress, and the coefficient of sliding friction. The Phase II objectives are directed towards use of the Phase I test and analysis methods to effectively develop improved composites and to better understand the role of the fiber-matrix interface in composite properties.

27902 (ORNL/FMP–89/2, pp. 51-56) **GT-1(A) - Modeling of fibrous preforms for CVD infiltration.** Starr, T.L. (Georgia Institute of Technology, Atlanta (USA)); Freeman, G.B.; Elston, T.C. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

Chemical vapor infiltration (CVI) has demonstrated considerable promise as a technique for fabrication of fiber reinforced ceramic composites. Unidirectional and bidirectional composites of SiC fibers in a SiC matrix have shown good strength and exceptional strain tolerance. Our efforts have continued in measuring the permeability of partially infiltrated composites, in relating these results to composite microstructure, and in incorporating backpressure calculations into the CVI model.

27903 (ORNL/FMP–89/2, pp. 57-65) **GT-1 - Development of advanced fiber-reinforced ceramics.** Starr, T.L. (Georgia Institute of Technology Research Institute, Atlanta (USA)); Harris, J.N.; Mohr, D.L.; Lyons, J.S. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The objective of this program is to develop an understanding of the critical factors in composite processing and to use this improved understanding to develop a silicon nitride composite microstructure for increased fracture toughness. The critical factors to be addressed are the nitriding process, the fiber-matrix interface, and processing-induced fiber orientation and residual porosity.

27904 (ORNL/FMP–89/2, pp. 67-75) **INEL-1(A) - Nondestructive evaluation of advanced ceramic composite materials.** Lott, L.A. (Idaho National Engineering Lab., Idaho Falls (USA)); Kunerth, D.C. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

Nondestructive Evaluation techniques (NDE) are being developed for characterizing advanced ceramic composite materials. These high temperature structural materials are currently of great interest for fossil energy applications because they exhibit significantly higher fracture toughness than monolithic ceramics. The NDE techniques being developed are designed to detect and characterize those material conditions known to affect toughness and strength in continuous fiber-reinforced composites. Examples of known conditions include the degree of bonding between fiber and matrix, damage such as fiber breakage and matrix cracking, and porosity content. Techniques under investigation include ultrasonic velocity and attenuation, acousto-ultrasonic (AU) response, acoustic emission, and internal dynamic mechanical damping. In support of efforts to develop ceramic matrix materials for fossil energy applications, the objective of this work is to develop and evaluate techniques to nondestructively characterize the fiber-matrix interface bonds. As reported in the previous semi-annual report (October 1988-March 1989), preliminary measurements showed significant differences in acousto-ultrasonic response between two samples of SiC reinforced SiC matrix composites having different interfacial bond characteristics.

27905 (ORNL/FMP–89/2, pp. 77-84) **INEL-1(B) - Joining of silicon carbide-reinforced ceramics.** Rabin, B.H. (Idaho National Engineering Lab., Idaho Falls (USA)). Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

This research program is exploring and developing techniques for joining silicon carbide matrix composites. Emphasis is being placed on silicon carbide fiber-reinforced silicon carbide matrix composites currently under development by DOE for use in fossil energy systems. This material is intended for structural applications at temperatures exceeding 1000°C. The goals of the research effort include: identification of appropriate joining methods, development of experimental procedures for joint fabrication, and characterization of the structure and properties of joints. An understanding of the factors that control joint performance will be obtained by studying the relationships between processing variables, joint characteristics, and mechanical behavior.

27906 (ORNL/FMP–89/2, pp. 85-88) **INEL-1(C) - Superconducting film fabrication.** Debsikdar, J.C. (Idaho National Engineering Lab., Idaho Falls (USA)); Samsel, E.G.; Sellers, C.H.; Telschow, K.L.; Miley, D.V. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

This program is investigating techniques for fabricating sol-gel derived films of $YBa_2Cu_3O_{7-x}$ (YBCO) based superconducting ceramics. This sol-gel approach involves controlled interactions of the alkoxide precursors of Y_2O_3, BaO, and CuO. Suitable barium alkoxide is available from commercial sources, however, suitable alkoxide precursors of CuO are not commercially available. Commercially available yttrium alkoxides are extremely moisture sensitive and, consequently, difficult to hydrolyze in a controlled manner. Therefore, one of the tasks of this program is to develop methods of synthesizing alkoxy compounds of copper and yttrium. The general tasks of this program include: synthesis of alkoxide precursors; development of sol preparation procedure(s); preparation of sol-gel derived powders; film fabrication using sol as well as sol-gel derived powder slurry; and characterization of films in terms of superconducting properties, microstructure, and chemical homogeneity. Efforts during the preceding six months concentrated on (1) fabrication and characterization of YBCO thin films, and (2) study of the chemical interactions at the YBCO film - $SrTiO_3$ substrate interface.

27907 (ORNL/FMP–89/2, pp. 89-102) **LANL-1 - Short fiber reinforced structural ceramics.** Shalek, P.D. (Los Alamos National Lab., NM (USA)); Parkinson, W.J. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

Two principal tasks are involved in this work. One is to modify and optimize the existing growth process to produce long SiC whiskers. As part of this task, the groundwork will be established to incorporate an artificial intelligence (AI) system in the whisker growth process. An AI system offers the potential for markedly improving the yield, quality, and reproducibility of a product at a fraction of the human resources. Such a payoff is attractive from the standpoint of technology transfer. The use of the long whiskers will require some reassessment of the harvesting and beneficiation procedures used for short whiskers. The second task entails the development of a staple whisker yarn. To help predict the performance of the yarn in composites, some work will continue in characterizing the strength of long VLS SiC whiskers as a function of temperature and surface treatment.

27908 (ORNL/FMP–89/2, pp. 103-120) **NIST-1 - Structural reliability and damage tolerance of ceramic composites for high-temperature applications.** Fuller, E.R. Jr. (National Institute of Standards and Technology, Gaithersburg, MD (USA)); Butler, E.P.; Krause, R.F. Jr.; Vaudin, M.D. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

With an objective of improved performance for heat engine/heat recovery applications, the NIST program addresses these problems through a determination and characterization of major toughening mechanisms in ceramic composites, examining both model crack-fiber systems and real composites. A key aspect of the program is a determination of the critical processing factors which influence microstructure and interfacial behavior in these materials, and which thereby influence these toughening mechanisms.

27909 (ORNL/FMP–89/2, pp. 121-128) **NCAT-1 - Mechanical properties testing of ceramic fiber-ceramic matrix composites.** Sankar, J. (North Carolina A and T State Univ., Greensboro (USA)); Kelkar, A.D. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

Ceramic fiber-ceramic matrix composites fabricated by forced chemical vapor infiltration (CVI) are currently being developed as practical engineering materials because of their potential high strength and toughness, especially at elevated temperatures. The goals of this project are to expand the mechanical properties data base for composites fabricated by forced CVI. In particular, SiC fiber reinforced SiC matrix system will be investigated under this program. The effect of the reinforcement and the interfacial bond of the composite on the tensile strength, thermal shock resistance, oxidation resistance, and tensile strength during cyclic loading, at

temperatures up to 1200°C, shall be investigated in the proposed work.

27910 (ORNL/FMP–89/2, pp. 129-134) **ORGDP-1 - Development of ceramic membranes for gas separation.** Fain, D.E. (Oak Ridge Gaseous Diffusion Plant, TN (USA)); Kidd, G.J.; Roettger, G.E.; White, D.E. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

Capabilities available at the Oak Ridge Gaseous Diffusion Plant (ORGDP) for fabricating and characterizing membranes are being applied to develop ceramic membranes for separating gases at high temperatures and pressures. The details of the fabrication methods are currently classified confidential-restricted data which was recently downgraded from secret-restricted data. Efforts are continuing to declassify relevant fabrication technology. Because of this classification, only qualitative discussion of the fabrication methods will be given. The initial goal of this project is to produce a membrane to recover hydrogen from the synthetic gas produced by coal gasification processes.

27911 (ORNL/FMP–89/2, pp. 135-137) **ORNL-1(A) - Fabrication of fiber-reinforced composites.** Stinton, D.P. (Oak Ridge National Lab., TN (USA)); Lowden, R.A.; Besmann, T.M. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The purpose of this task is to develop a ceramic composite having higher than normal strength and toughness yet retaining the normal ceramic attributes of refractoriness and high resistance to abrasion and corrosion. Ceramic fiber-ceramic matrix composites are being fabricated by infiltrating fibrous structures with vapors that deposit on and between the fibers to form the matrix of the composites.

27912 (ORNL/FMP–89/2, pp. 139-143) **ORNL-1(C) - Characterization of fiber-CVD matrix interfacial bonds.** Lowden, R.A. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The purpose of this task is to optimize the strength and toughness of fiber-reinforced ceramic composites by controlling the bonding and frictional stresses at the fiber-matrix interface. Methods must be developed to characterize fiber-matrix interactions and measure interfacial stresses in fiber-reinforced ceramic composite systems. Coating or pretreatment processes can then be utilized to tailor the fiber-matrix interfacial stresses within various composite systems and to optimize the strength and toughness of the composite.

27913 (ORNL/FMP–89/2, pp. 145-147) **ORNL-1(D) - Microwave sintering of ceramics.** Janney, M.A.; Kimrey, H.D.; Calhoun, C.L. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

We are conducting a series of side-by-side experiments to compare the effects of microwave vs conventional sintering. To date, we have completed an evaluation of microwave sintering in a 2.45-GHz microwave furnace utilizing a picket fence approach. This arrangement uses five of SiC rods [0.64 cm diam (25 in.) by 10 cm long (4 in.)] mounted vertically in a 10-cm-diam circle, giving a spacing between rods of about 6 cm. This approach was necessary to facilitate controlled microwave heating of the zirconia from ambient temperature to the sintering temperature.

27914 (ORNL/FMP–89/2, pp. 149-177) **PNL-1(A) - Investigation of electrochemical processes in high-temperature solid electrolytes.** Bates, J.L. (Pacific Northwest Lab., Richland, WA (USA)); Chick, L.A.; Youngblood, G.E.; Weber, W.J. Oak Ridge National Lab., TN (USA). Jan 1990. DOE Contract AC06-76RL01830. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The purpose of this research and development effort is to (1) identify, develop, and demonstrate advanced materials for use as alternative electrodes, current interconnections and electrolytes in high-temperature solid-electrolyte electrochemical cells, and (2) develop an understanding of the synergistic effects of materials properties, structures and compositions on electrochemical processes in high-temperature solid electrolyte electrochemical cells.

27915 (ORNL/FMP–89/2, pp. 219-227) **B and W-2 - Evaluation of the fabricability of advanced austenitic tubing.** LeBeau, S.E. (Babcock and Wilcox Research, Alliance, OH (USA)). Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The scope of the current program consists of melting experimental alloys, conditioning of ingots and forging of ingots into extrusion billets, and production of seamless tubing. A portion of some of the sample tubing will be clad on the outside with high-chromium, high-nickel alloys (Alloy 671, 690) for corrosion protection. Specific details on each of the processing routines and results of chemical and metallurgical testing of tubing produced last year presented in earlier reports issued to Martin Marietta Energy Systems. Samples of the tube produced under this task will be used in complementary tasks to examine the mechanical behavior, weldability, and fireside and steamside corrosion of the tubing.

27916 (ORNL/FMP–89/2, pp. 229-237) **CSM-2 - Investigation of the weldability of polycrystalline iron aluminides.** Ash, D.I. (Colorado School of Mines, Golden (USA)); Edwards, G.R.; David, S.A. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

Interest in developing polycrystalline, long-range ordered alloys for high temperature applications is great because of unique properties, such as increasing strength with temperature, which is a consequence of dislocation interactions in the ordered structure. For applications approaching 600°C, iron aluminides based on the Fe_3Al-DO_3 structure have recently held interest, due to low cost, and desirable strength, corrosion and oxidation properties. This joint Colorado School of Mines and Oak Ridge National Laboratory investigation was established to develop a fundamental understanding of the cracking phenomena in this material, and to also understand the phase transformations associated with alloys near the Fe_3Al composition. The first phase of this investigation was concerned with the effect of a weld thermal cycle on the hot ductility of chromium- and niobium-modified Fe_3Al. Structural characterizations of this material, including optical microscopy, differential scanning calorimetry (DSC), and x-ray diffraction were performed on sheet samples.

27917 (ORNL/FMP–89/2, pp. 239-250) **CU-2 - Mechanical properties and microstructural stability of advanced austenitic alloys.** Ferro, P.D. (Cornell Univ., Ithaca, NY (USA)); Coulombe, B.D.; Li, C.Y. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The goals of this project have been to obtain mechanical property data which can be used to screen alloys developed for use in advanced fossil plants, and to characterize the long-term mechanical properties of the promising alloys. In the past six months, we have continued the effort to improve high-temperature flow strength of modified alloy 800H. The work reported for this period includes the investigation of temperature dependence of flow properties, time-temperature dependence of carbide precipitation, and grain

size control. Two of the proposed cladding materials for corrosion protection have also been investigated (Inconel 671 and 690). Some deformation properties of these alloys are reported.

27918 (ORNL/FMP–89/2, pp. 263-269) **ORNL-2(B) - Development and evaluation of advanced austenitic alloys.** Swindeman, R.W.; Goodwin, G.M.; Maziasz, P.J.; Bolling, E. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The purpose of this task is to evaluate advanced austenitic alloys for the design, construction, and reliable operation of advanced heat recovery systems and hot-gas cleanup systems. As these studies near completion, more effort will be placed on compositions suitable for hot-gas cleanup systems. Alloys will be selected and evaluated for the types of thermal and mechanical conditions that might be expected in tubesheets and manifolding in filter vessels for both PFBCs and gasifiers.

27919 (ORNL/FMP–89/2, pp. 271-282) **ORNL-2(F) - Development of iron aluminides.** McKamey, C.G.; Sikka, V.K.; Liu, C.T. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The objective of this task is to develop low-cost, low-density intermetallic alloys based on Fe_3Al with an optimum combination of strength, ductility, and corrosion resistance for use as components in advanced fossil energy conversion systems. During this reporting period, several new alloys were arc-melted under argon and drop-cast into water-cooled copper molds to produce our standard experimental size casting of 500 g. Several of these alloys have ternary compositions based on Fe-28Al (all alloy compositions are reported in at. %) and were produced to determine the effect of the ternary additive on either tensile or creep properties.

27920 (ORNL/FMP–89/2, pp. 283-293) **OSU-2 - Fundamental study of aluminizing and chromizing processes.** Harper, M.A. (Ohio State Univ., Columbus (USA)); Miller, D.A.; O'Connell, D.; Rapp, R.A. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The purpose of this project is to develop a fundamental understanding for the deposition of diffusion coatings containing the desired concentrations of Cr-Al or Cr-Si using the pack cementation method. In this way, strong, fabricable, and inexpensive substrates can be provided with a suitable combination of corrosion resistance and mechanical properties.

27921 (ORNL/FMP–89/2, pp. 295-337) **UTN-2 - Investigation of welding and joining techniques for advanced austenitic alloys.** Lundin, C.D. (Univ. of Tennessee, Knoxville (USA)); Qiao, C.Y.P.; Gill, T.P.S.; Ren, W. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

Modified 316 stainless steels (lean 316 stainless steels) have been recently developed at ORNL based upon the compositions of materials used for nuclear applications. The basic modification is achieved by using carbide forming elements and solid solution elements plus a thermal-mechanical treatment consistent with superheater tube production procedures to improve the elevated temperature properties of these steels. The weldability studies on modified 316 alloys have been conducted at The University of Tennessee and the primary hot ductility and hot cracking test results were presented in the last semiannual report.

27922 (ORNL/FMP–89/2, pp. 339-341) **WHC-2 - Investigation of electro-spark deposited coatings for protection of materials in sulfidizing atmospheres.** Johnson, R.N. (Westinghouse Hanford Co., Richland, WA (USA)). Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The objective of this program is to develop candidate coatings, using the electro-spark deposition (ESD) process, for the protection of materials in sulfidizing atmospheres typical of fossil energy applications. Coatings of interest include single or multilayer deposits of commercially available hardfacing alloys, as well as custom formulations of metal aluminides, chromium alloys, refractory metals, carbides, silicides, and borides. Materials to be protected include low alloy steels, Alloy 800, Type 310 stainless steel, and modified (lean) stainless steels.

27923 (ORNL/FMP–89/2, pp. 345-373) **ANL-3 - Corrosion and mechanical properties of alloys in FBC and mixed-gas environments.** Natesan, K. (Argonne National Lab., IL (USA)); Park, J.H. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

During the current period, extensive studies have been conducted to evaluate the electrical conductivity of thermally grown chromium oxide scales using electrochemical cells. The results have been used to assess the defect structure in the oxide and to evaluate the transport properties of the oxide scale. In addition, the effect of sulfur dopant in the gas phase on the conductivity and transport properties in the oxide is evaluated.

27924 (ORNL/FMP–89/2, pp. 375-392) **BCL-3 - Investigation of the effects of microalloying constituents and oxidation conditions on the development and breakdown of protective oxide layers.** Wright, I.G. (Battelle, Columbus, OH (USA)); Colwell, J.A.; Baer, D.R.; Schoenlein, L.H. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The objectives of this program are (1) to gain an improved understanding of the effects of alloying constituents present at low levels on the development and mode of breakdown of protective oxide scales, in conditions representing those encountered in combustion and gasification processes at 500 to 700 C, and (2) to achieve better control over the growth of scales which will contribute to improvements in long-term, high-temperature corrosion resistance of heat exchanger and heat recovery materials.

27925 (ORNL/FMP–89/2, pp. 393-403) **CWR-3 - Investigation of the effects of microalloy constituents, surface treatment and oxidation conditions on the development and breakdown of protective oxide scales.** Vedula, K. (Case Western Reserve Univ., Cleveland, OH (USA)). Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The focus of this research program is an understanding of the development and breakdown of oxide scales on Fe-25Cr, Fe-25Cr-20Ni and Fe-25Cr-6Al alloys in atmospheres containing oxygen and sulfur at temperatures in the range of 500 to 700°C. Experiments were carried out at 700°C in oxidizing conditions using H_2/H_2O gas mixtures or in oxidizing/sulfidizing conditions using $H_2/H_2O/H_2S$/Ar gas mixtures. The research emphasized during this reporting period includes an understanding of the details of the formation and breakdown of oxide scales on the Fe-25Cr-20Ni alloy. These results are summarized below under sections A, B, C and D. Section E is a discussion of the role of Ni in this alloy by comparing the behavior of this alloy with the Fe-25Cr and Fe-25Cr-6Al alloys.

27926 (ORNL/FMP–89/2, pp. 405-436) **LBL-3 - Studies of materials erosion in coal conversion and utilization systems.** Levy, A.V. (Lawrence Berkeley Lab., CA (USA)). Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced*

Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989. Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The erosion of material surfaces by small solid particles carried in gas and liquid carriers is being investigated. The materials are tested over a range of conditions that simulate portions of the operating environment of containment surfaces in coal gasification, liquefaction and fluidized bed combustion processes. In order to determine the effect of the ratio of sand (SiO_2) to limestone ($CaCO_3$) and to calcined limestone (CaO) on the formation of the protective layer and the resultant amount of metal wastage that occurred on 1018 steel, a series of erosion-corrosion tests was carried out at conditions that nearly simulated those in the convection pass region of FBCS. Various laboratory prepared sand-limestone and sand-calcined limestone mixtures were used as the erodents in the investigation.

27927 (ORNL/FMP–89/2, pp. 437-445) **MIT-3 - Materials data base development for refractories.** Buyukozturk, O. (Massachusetts Institute of Technology, Cambridge (USA)); Shin, S. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

This program comprises experimental works for dense and insulating refractory materials. The experimental works involve uniaxial monotonic and cyclic loading tests at room and elevated temperatures. They also involve constant load tests under varying temperatures. In this period, thermomechanical properties of the selected dense castable refractory material have been developed. The results of monotonically increasing short-term uniaxial compressive load tests carried at MIT under the current project have been included.

27928 (ORNL/FMP–89/2, pp. 467-475) **ORAU-3 - Study of the incubation stage of erosion of 1,100 aluminum.** Rao, M. (Oak Ridge Associated Universities, TN (USA)); Keiser, J.R. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

Studies of solid particle erosion of metals and alloys have been carried out for a number of years, both on mechanistic interpretations of the process as well as the influence of materials properties on erosion resistance. It is now well established that ductile materials initially go through an incubation period where there is little or no mass loss followed by a steadily increasing rate of material loss. For oblique impact, there have been a few studies on the characteristic hill-and-valley ripple structure that develops on the surface through incubation. For normal impact, melting and recrystallization have been observed in pure aluminum during incubation. However, in general, there is little information available concerning changes that occur specifically during incubation.

27929 (ORNL/FMP–89/2, pp. 485-494) **ORNL-3(B) - Effects of a reactive element on the impact response of oxide scales.** Tortorelli, P.F.; Keiser, J.R. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

In the present study, where preformed oxide scales are subjected to microscopic impacts, toughening refers to the ability of the oxide scale to resist crack nucleation and growth under energetic impact by tungsten carbide spheres. The purposes of such experiments are quite specific (and do not necessarily relate to other phenomena associated with protective oxide scales); to better understand how scales accommodate strain in terms of cracking and to see what effect RE additions may have on this impact response.

27930 (ORNL/FMP–89/2, pp. 495-511) **UES-3 - Investigation of the effects of microalloy constituents, surface treatments and oxidation conditions on the development and breakdown of protective oxide scales.** Srinivasan, V. (Universal Energy Systems, Dayton, OH (USA)); Kung, Sicheng. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The purpose of this investigation is to understand and gain control over the metallurgical and processing factors that promote the formation of adherent corrosion-resistant protective chromia and alumina scales for long term application in coal combustion and gasification environments. The scope of this investigation includes corrosion study on alloys containing minor alloying additions, the effect of surface pretreatment and ion implantation of typical reactive and other alloying elements. Analysis of scales was performed on unimplanted and Ce-implanted Fe-25Cr alloy before and after different exposures using scanning and transmission electron microscopy (STEM).

27931 (ORNL/FMP–89/2, pp. 513-523) **UCB-3 particle motion in flows past tubes.** Humphrey, J.A.C. (Univ. of California, Berkeley (USA)); Smith, L.L. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The aim of this project has been to evaluate computationally, for a variety of flows and tube configurations, erosion by particles of tubes in the cross-flow. The first step in this process was to compute the flow field, and from this to calculate the particle paths and fluxes. During the past year this work has been extended by the present authors to include heat transfer effects. The FLOW and PARTICLE codes have been modified accordingly.

27932 (ORNL/FMP–89/2, pp. 525-545) **UCIN-3(A) - High temperature corrosion of aluminides.** Lee, W.H. (Univ. of Cincinnati, OH (USA)); Lin, R.Y. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The objectives of this program are to investigate the high temperature degradation of aluminides developed at Oak Ridge National Laboratory (ORNL) in the environments of simulated coal combustion or gasification, to understand the effect of alloying element on the corrosion behavior of aluminides at high temperature, and to provide scientific know-hows for the further modification of aluminides to improve their high temperature corrosion resistance. The emphasis of this program is on the material corrosion induced by molten salts, or hot corrosion as it is generally accepted.

27933 (ORNL/FMP–89/2, pp. 547-566) **UCIN-3 - Study of particle rebound characteristics and material erosion at high temperatures.** Tabakoff, W. (Univ. of Cincinnati, OH (USA)); Hamed, A.; Metwally, M.; Yeuan, J. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

Presently research work is underway to simulate single solid particle impact on a solid target material using existing plastic theory. The range of the impact particle velocity is under 500 m/s. The particle impact is solved by using a computer program which is based on the theory of perfect-elastic mechanics. The solid particle and the target material are considered as perfect plastic-elastic bodies, and the effect of strain rate on the strength of the materials are included in this study. The entire impact process is involved with the adhesion, deformation and rebound process which are useful in basic understanding of the erosion process. Some initial results of the computer modeling are presented.

27934 (ORNL/FMP–89/2, pp. 567-591) **UND-3 - A study of erosive particle rebound parameters.** Kosel, T.H. (Univ. of Notre Dame, IN (USA)). Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development*

Materials Program. Semiannual progress report for the period ending September 30, 1989. Order Number DE90008393. Available from NTIS, PC A25/MF A01.

This research is designed to provide a systematic investigation of the effects of materials properties and experimental variables on the rebound directions and velocities of erodent particles. The project is now nearing full maturity, with the spherical and angular impact model development essentially complete and with the recent completion of both the single and multiple particle rebound test systems. In the present report we include a significant set of single particle rebound test results, as well as some preliminary results from the multiple particle rebound system. Preliminary comparisons are made between the computer models and the spherical particle data. Progress in the various subsections of the project is described below.

27935 (ORNL/FMP–89/2, pp. 593-604) **UTN-3 - Aqueous corrosion of iron aluminides.** Buchanan, R.A. (Univ. of Tennessee, Knoxville (USA)); Kim, J.G. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

It is the overall purpose of the present project to study the aqueous corrosion characteristics of these experimental iron aluminides. This report summarizes activities over the past six months, which have included: (1) evaluations of corrosion behavior of promising iron-aluminide compositions under long-term immersion conditions, (2) a study of the effects of heat treatment and resultant superlattice structure on corrosion behavior, (3) evaluations of anodic-polarization and corrosion-rate behavior of selected iron aluminides in acid-chloride, thiosulfate, and the trathionate solutions, and (4) evaluations of U-bend stress-corrosion-cracking (SCC) tendencies of an iron aluminide in the three previous solutions.

27936 (ORNL/FMP–89/2, pp. 617-618) **3M-4 - Fabrication of commercial-scale fiber-reinforced hot-gas filters by chemical vapor deposition.** Kafka, T.M. (3M Co., St. Paul, MN (USA)). Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The filters to be developed in this subcontract will consist of ceramic fibers embedded in a SiC matrix, with the matrix produced by CVD. Compared to candle filters, relatively thin membranes will be developed, not greater than 6.4 mm (0.25 in.) in thickness, in order to obtain good cleanability and thermal shock tolerance. The ceramic fibers will be completely coated with SiC so that good chemical resistance will also be obtained. Characterization will involve tests on both preforms and filters. Permeability will be measured on preforms and on filters. Mechanical testing will include burst testing at room temperature and 4-point bend tests at both room and elevated temperatures.

27937 (VTT-TUTK–654) **Improvement of the operation safety of total energy units used for producing heat and energy: Part 2. Experiments with LPG and natural gas.** Kytoe, M. (Valtion teknillinen tutkimuskeskus, Espoo (Finland). Polttoainejalostustekniikan laboratorio); Eklund, T.; Nylund, N.O. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Sep 1989. 50p. (In Finnish). Order Number DE90770749. Available from NTIS (US Sales Only), PC A03/MF A01.

A total energy unit is a combination of an engine and a generator in which, in addition to electricity production, the waste heat of engine is recovered. In the present report, experiments with natural gas and LPG (propane) fueled engine in an engine dynamometer and with LPG in the total energy unit are discussed. A spark-ignition engine modified from a three-cylinder diesel engine was used in the experiments. The diesel engine was changed into spark-ignition by substituting spark plugs for the injectors and a distributor for the injection pump and by reducing the compression ratio. The engine was equipped with a three-way catalyst. The maximum efficiency of the engine with LPG and natural gas was 34-35% and that of the diesel engine was 36-37%. Compared to a naturally aspirated diesel engine the power with gas was 1-3 kW higher and with LPG about 2 kW higher than with natural gas over the whole speed range. The maximum power with propane was 49,5 kW. The efficiency of the total energy unit with propane was 78-82%. For an output of 10 kW the efficiency of electricity generation was about 16% and for an output of 30 kW about 26%. At small outputs the power of 1 kW required by auxiliary equipment clearly affects the efficiency. From the total energy input, 20% was recovered from the exhaust gases and 34-44% from the coolant. The emission values of uncleaned exhaust gases from the spark-ignition engine were higher than those from a corresponding diesel engine, but the three-way catalyst cleaned the exhaust gases very efficiently. The minimum conversion degree obtained for carbon monoxide and unburned hydrocarbons was 95% in measurements after 1000 hours of operation.

27938 **Flyash adhesion in simulated coal-fired gas turbine environment.** Ahluwalia, R.K. (Argonne National Lab, Argonne, IL (US)); Im, K.H.; Wenglarz, R.A. *Journal of Engineering for Gas Turbines and Power (USA),* 111(4): 672-678 (Oct 1989).

A rich-quench-lean subscale turbine combustor has been used to expose specimens to the products of combustion from several beneficiated coal-water fuels. An analytical scheme is formulated to extract sticking coefficients from the measured weight gain data, particle size spectrum, and particle density and composition. The inferred sticking coefficients, appropriate for impaction on the pressure surface, range between 0.0003 and 0.11 and are strong functions of the gas and surface temperatures but rather insensitive to the impact angle. The implications of these results on coal-fired gas turbine operation are discussed.

27939 **Cofiring of pelletized refuse-derived fuel with coal to achieve sulfur dioxide emissions requirements.** Ohlsson, O.O. (Argonne National Lab., IL (USA)); Pearson, C.V.; Lazar, J. *Proceedings of the American Power Conference (USA),* 50: 794-797 (1988). (CONF-880403–: American power conference, Chicago, IL (USA), 18-20 Apr 1988).

Processing of municipal solid waste with lime additives has produced a high quality, storable, fuel pellet. Earlier studies of the beneficial effect of lime addition to coal and of the cofiring of lime-rich refuse-derived fuel pellets with coal suggested cofiring these pellets with Illinois or Kentucky coals in order to reduce sulfur dioxide emissions. A series of burn tests were conducted at Argonne National Laboratory in the summer of 1987 to verify the rate and conditions for optimum sulfur capture. Pellets with lime additions of 4-8% (by weight) were fired at 10, 20, or 30% (by ratio of heat input) with coal. This paper presents the results to date.

27940 **Turbine-generator replacement study.** Miller, E.F. (Burns and Roe Enterprises, Inc., Oradell, NJ (USA)); Stuhrke, S.P., Shah, A.A. *Proceedings of the American Power Conference (USA),* 50: 880-892 (1988). (CONF-880403–: American power conference, Chicago, IL (USA), 18-20 Apr 1988).

This paper describes an engineering study for the replacement of a nominal 70 Mw turbine-generator in a multi-unit utility cogeneration station. The existing plant is briefly described, alternatives considered are discussed, and the conclusions reached are presented. Key topics are the turbine steam cycle evaluation and the turbine pedestal analysis.

2002 Waste Management

Refer also to citation(s) 27445, 27454, 27496, 27497, 27498, 27499, 27500, 27501, 27939, 27949, 28356, 28357, 29024, 29030, 29034

27941 (CONF-8810352–) **Metals research and development: Applications in the field of energy in Italy. Meeting organized by AIM (Italian Association of Metallurgy) and ENEA. Milan, 19-20 Oct 1988.** ENEA, Rome (Italy); Associazione Italiana di Metallurgia, Milan (Italy). Oct 1988. 298p. (In Italian). From Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988. Order Number DE90764258. Available from NTIS (US Sales Only), PC A13/MF A01.

There are four different sections inside the proceedings which concern: general problems relevant to materials characterization

and technological innovation criteria for metallurgical processes, non-ferreous materials (i.e. copper, titanium), high temperature, corrosion resistant, ferreous materials and superalloys (i.e. chronium-molybdenum-nickel steels for fossil-fuel power plant components and desulfurization systems). Separate abstracts were prepared for all the papers of this meeting.

27942 (KTM/E-D--179) **Development of sampling and measurement techniques and analysis methods for the measurement of emissions from energy production.** Aittola, J.P. (Valtion Teknillinen Tutkimuskeskus, Jyvaeskylae (Finland). Polttoaine- ja Polttotekniikan Lab.); Vesterinen, R.; Hahkala, M.; Kauppinen, E.; Lauarinen, A.; Tirkkonen, T. Kauppa- ja Teollisuusministerio, Helsinki (Finland). Energiaosasto. 1989. 52p. (In Finnish). Project 304/881/85. Order Number DE90770712. Available from NTIS (US Sales Only), PC A04/MF A01.

The project " DEVELOPMENT OF SAMPLING AND MEASUREMENT TECHNIQUES AND ANALYSIS METHODS FOR THE MEASUREMENT OF EMISSIONS FROM ENERGY PRODUCTION"made technical descriptions of the different sampling, measurement and analysis methods used in emission measurements. Intercalibration measurements using different techniques were made on emissions at plants. On the basis of these measurements and the technical survey made on methodology, new sampling, measurement and analytical techniques and methods were developed. Important part of the project was the transfer of technical knowledge abroad to Finland. A new measurement system was developed for the real-time measurement of particle size distributions in aereolsols in incineration emissions. The system consists of both the dilution equipment for the flue gases and a computer steerd particle size analyser. To sample organic micropollutants a high volume sampler was developed. In the project some intercalibration measurements for a number of organic as well as inorganic compounds in the flue gases were made. Samples were taken by usin the " Scandinavian sampling system" (proposed by SNV, Sweden), the high volume sampler developed in the project, a Norwegian modificated EPA-5 train and a new sampling concept developed by The University off Umeaa, Sweden. Intercalibration sampling and measurements were also made for particulates, sulphurdioxide and nitric oxides in the power plant emissions. The efficiency of absorption sampling method for heavy metals was also studied. The development and comissioning of new and continuous measurement and analysis methods for different emission components (organic micropollutants, metallic elements, etc.) is of primary importance. The methods used to day must be developed so that the results are readily available and reliable.

27943 (ORNL/FMP--89/2, pp. 251-252) **FW-2 - Fireside corrosion testing of candidate superheater tube alloys, coating, and cladding.** Blough, J.L. (Foster Wheeler Development Corp., Livingston, NJ (USA)). Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The efficiency of a steam generator is largely controlled by the operating temperature and pressure. Although the present economic climate does not require new more efficient power plants, there is increased pressure to reduce emissions of all types, SO_x, NO_x and possibly CO_2. Although it is technically possible to capture the CO_2, the economics dictate that the preferred method for the reduction of CO_2 is to make the plant more efficient, (i.e., higher temperatures and pressures). A program is being conducted to evaluate the corrosion resistance of selected superheater and reheater tube alloys to aggressive coal ash environments containing alkali-iron-trisulfates. Retort testing exposing 15 metal samples coated with synthetic coal ash in flowing synthetic flue gas at 650 to 760°F will be performed.

27944 (SV-UV--1989-31) **Nitrous oxide emissions from different combustion sources.** Andersson, Curt; Braennstroem-Norberg, B.M.; Hanell, B. Swedish State Power Board, Vaellingby (Sweden). 18 Aug 1989. 73p. Order Number DE90770796. Available from NTIS (US Sales Only), PC A04/MF A01.

The level of international knowledge regarding emissions and measurements of N_2O from combustion sources has been summarised. Supplementary measurements of N_2O emission from some power plants have been carried out. In connection with this, power plant techniques were selected - gasification, natural gas fired plants and combined cycle - which can be of interest in in Sweden. N_2O emission is consistently low for all investigated methods of combustion and fuels with the exception of coal fired atmospheric fluidized beds. Values shown earlier are probably too high as a result of sampling artifacts. There are several indications that N_2O emissions in flue gas are not increased after having passed through catalytic NO_x reduction (SCR) but may instead be slightly reduced. (7 figs., 28 tabs.).

27945 **Compatibility of admix and synthetic liner materials with flute gas scrubbing wastes.** Volume 2. Koegler, S.S. (Battelle Pacific Northwest Lab., Richland, WA (USA)). 16p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679--: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

88-28.4.

This paper describes research on processes which control SO_2 emissions from utility power plants. These processes produce wastes consisting of fly ash, sulfates, and additives from the desulfurization processes. In a two-year screening study, chemical compatibility of these wastes with a variety of admix (admixture) and synthetic membrane liners were investigated. Wastes from four different flue gas cleaning processes (fluidized bed combustion, spray dryer, dry sodium-based sorbent injection, limestone furnace addition) and the advanced coal cleaning process were evaluated in these tests. The tests were designed to detect the relative changes in liner properties which occurred from exposure to the wastes to determine liner/wastes to determine liner/waste incompatibilities and select suitable liners for further long-term testing.

27946 **Injection of deuterated methane into the stack of a coal-fired power plant to trace stack emissions.** Volume 3. Mroz, E.J. (Los Alamos National Lab., NM (USA)); Alei, M. 10p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679--: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

88-52.3.

The winter haze intensive tracer experiment was designed to evaluate an empirical approach for assessing the relative contribution of an isolated source to aerosols at specified locations. The Lake Powell area of southeastern Utah was chosen for the location of this experiment because of previous observations of persistent wintertime hazes. The rugged terrain and the association of the haze with stagnant meteorological conditions suggested that major local sources such as the Navajo Generating Station (NGS) could contribute to the haze. Since the composition of emissions from the several coal-fired power plants in the region are quite similar, it was necessary to tag the NGS emissions with a unique tracer. The tracer employed in this study was deuterated methane (CD_4). The tracer concentrations are measured by an isotope ratio mass spectometric technique. This conservative tracer has been used in several experiments to trace long-range atmospheric transport. This paper discusses the experiment. This experiment required that the tracer be injected into the stack gases of coal-fired power plant. Therefore it was necessary to ascertain whether the tracer would be uniformly mixed in the stack gases before existing the stack and whether the tracer was conserved during its passage through the stack environment.

27947 **Dielectric-Barrier Discharge for the Removal of SO_2 from flue gas.** Dhali, S.K. (Dept. of Electrical Engineering, Southern Illinois Univ., Carbondale, IL (US)); Sardja, I. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8905184--: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The experimental results of the removal of SO_2 from a synthetic flue gas using a dielectric-barrier discharge are reported. The dielectric-barrier discharge, also known as silent discharge or partial discharge, is widely used in industry for ozone synthesis. This

discharge is intermittent and the current exhibits a large number of spikes during that part of the voltage period when the discharge is burning. The discharge electrode configuration is coaxial. The inner electrode is either exposed metal or is covered with glass, and the outer electrode is quartz coated with a conducting surface.

2005 Environmental Aspects

Refer also to citation(s) 27945, 27946, 28984, 29034

27948 (PB–90-161928/XAB) **Definitions of critical environmental conditions for selected Chesapeake Bay finfishes exposed to acidic episodes in spawning and nursery habitats. Final report.** Klauda, R.J. Johns Hopkins Univ., Shady Side, MD (USA). Aquatic Ecology Section. Oct 1989. 172p. Available from NTIS, PC A08/MF A01.

Definitions of critical environmental conditions associated with acidic episodes are defined for yellow perch, alewife, blueback herring, American shad, and white perch, based on a review of field and laboratory data. These species are an important biological resource in the mid-Atlantic Coastal Plain. Values for blueback herring and alewife reproduction are an acid pulse between pH 5.5 and 6.2 with dissolved Ca at least 2 mg/l, with total monomeric Al levels between 15 and 137 microgram/l. Critical acidic conditions for American shad reproduction are an acid pulse between pH 5.7 and 6.7, dissolved Ca at least 2 micrograms/l, and total monomeric Al levels between 0 and 137 micrograms/l. Using data from the congeneric striped bass as a proxy, critical acidic conditions for white perch are an acid pulse between pH 6.5 and 6.7, total monomeric Al concentration of 25 microgram/l persisting for 7 days, and dissolved Ca at least 2 microgram/l. Based on a combination of life stage exposure and tolerance to acidic conditions the species can be ranked from high to low potential with regard to risks posed by acidic episodes on their early life stages: white perch, alewife/blueback herring, American shad, yellow perch.

27949 The use of audibility analysis to minimize community noise impact of today's smaller generation facilities located near residential areas. Liebich, R.E. (Argonne National Lab., IL (USA)); Cristoforo, M.P. *Proceedings of the American Power Conference (USA),* 50: 903-910 (1988). (CONF-880403–: American power conference, Chicago, IL (USA), 18-20 Apr 1988).

This paper demonstrates practical applications of the Fidell-Horonjeff audibility model to the analysis of power plant noise sources, such as cooling towers, transformers, pumps, ventilation fans, mobile diesel-powered yard equipment, loudspeaker systems, and even sodium-vapor-type outdoor lighting. Because plant-design engineers currently are relatively unfamiliar with the Fidell-Horonjeff model, the first part of this paper summarizes and reviews the model.

2006 Economic, Industrial, and Business Aspects

Refer also to citation(s) 27508

27950 (SV-US–1989-33) **Cogeneration.** Swedish State Power Board, Vaellingby (Sweden). 1989. 298p. (In Swedish). Order Number DE90770799. Available from NTIS (US Sales Only), PC A13/MF A01.

Existing and future technologies for cogeneration in the 1-100 MW ranges are reviewed. Efforts have been made to analyze performance and economy of the different plants in a uniform manner. The technologies presented are supposed to represent the normal status at the beginning of the next century. The economy of the plants have been analyzed through sensitivity analysis. Some main conclusions are: the competitiveness of cogeneration has been identified; the taxation principles for energy are of outmost importance; there is no need to await new technology for starting to build cogeneration plants. In a long perspective, R and D effort should be concentrated on combustion of solid fuels in diesel engines and gas turbines, and on molten carbonate fuel cells. (L.E.).

27951 (SV-UV–1989-32) **Coal-fired baseload power stations: A comparison of technical alternatives.** Matsson, R. Swedish State Power Board, Vaellingby (Sweden). 18 Sep 1989. 40p. Order Number DE90770797. Available from NTIS (US Sales Only), PC A03/MF A01.

This report sets out experiences gained from the Brannaes power station project. The object of the project was to compare three technical alternatives for a coal-fired power station at a prescribed site. These were: advanced pulverized coal combustion, combustion in pressurized fluidized beds and coal gasification. The results and conclusions obtained from the project are specific to the conditions applicable in this case and cannot be generalized. In investigations carried out elsewhere, other conclusions have been drawn. A general conclusion which can be drawn, however, is that pulverized coal combustion, an established technique, will be the cheapest in the face of current environmental requirements. At the same time both the other alternatives show such potential in terms of both environmental performance and economics that the continued development of these is justified.

27952 Where are the controls on the conservation power plant. Stokes, G.M. (Battelle, Pacific Northwest Lab. (US)). VP of Community and local government conservation programs. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808247–: Planning and forecasting, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

The concept of a conservation power plant is discussed. This supply-side viewpoint of conservation has been tested in the Hood River Project and is a major element of the long-term strategy of some utilities, such as the city of Austin, which is planning to acquire a 553 mW conservation power plant over the next decade. This paper examines the problem of the control of the conservation power plant in real operation. It emphasizes three elements of control: the need for control, real-time and near-real-time measures of conservation power plant performance, and implementation strategies for controls. The approach to the problem is based on a hierarchical analysis of electrical distribution systems. This analysis identifies the key points within a utility distribution system at which information can be collected. The strategy emphasizes the use of a great deal of information normally available within a utility, such as billing data and substation monitoring, as well as the use of limited end-use data collection. Issues of conservation implementation strategies and long-term efficacy of conservation measures are addressed.

21 NUCLEAR POWER PLANTS

Refer also to citation(s) 28057, 28067, 28408, 28409, 28410, 28547, 29850, 29851, 29888

27953 (NUREG–0020-Vol.14-No.2) **Licensed operating reactors: Volume 14, No. 2: Status summary report data as of January 31, 1990.** Nuclear Regulatory Commission, Washington, DC (USA). Office of Information Resources Management. Apr 1990. 515p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A22/MF A01 - GPO - OSTI.

The Operating Units Status Report — Licensed Operating Reactors provides data on the operation of nuclear units as timely and accurately as possible. This information is collected by the Office of Information Resources Management from the Headquarters staff on NRC's Office of Enforcement (OE), from NRC's Regional Offices, and from utilities. The three sections of the report are: monthly highlights and statistics for commercial operating units, and errata from previously reported data; a compilation of detailed information on each unit, provided by NRC's Regional Offices, OE Headquarters and the utilities; and an appendix for miscellaneous information such as spent fuel storage capability, reactor-years of experience and non- power reactors in the US.

2101 Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled

Refer also to citation(s) 27705, 27706, 27708, 27967, 27979, 27982, 27987, 28006, 28037, 28039, 28042, 28043, 28044, 28045, 28046, 28054, 28055, 28056, 28068, 28074

27954 (EPRI-NP–6005) **Proceedings: 1987 symposium on chemistry in high-temperature water.** Izatt, R.M. (Brigham Young Univ., Provo, UT (USA)); Oscarson, J.L.; LindH, G.C. Electric Power Research Inst., Palo Alto, CA (USA); Brigham Young Univ., Provo, UT (USA). c Mar 1990. 794p. Sponsored by Electric Power Research Institute. (CONF-8708178–: Symposium on chemistry in high temperature aqueous solutions, Provo, UT (USA), 25-27 Aug 1987). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Symposium on Chemistry in High Temperature Aqueous Solutions was organized to afford an opportunity to bring together those interested in this topic. Those who attended included scientists and engineers who had produced research results in the field and/or developed modeling procedures for interpretation of experimental data. In addition, EPRI personnel and plant operators were in attendance. Topics presented included chemistry, data acquisition, modeling, and industrial needs and assignment of priorities. Each report will be cataloged individually. 810 refs., 212 figs., 82 tabs.

27955 (EPRI-NP–6710-M) **Proceedings: Workshop on the role of sulfur species on the secondary-side degradation of Alloy 600 and related alloys.** Gustafsson, U.E.; Shoemaker, C.E. (eds.). Electric Power Research Inst., Palo Alto, CA (USA). c Mar 1990. 18p. Sponsored by Electric Power Research Institute. (CONF-8510516–Summs.: Workshop on the role of sulfur species on the secondary-side degradation of alloy 600 and related alloys, Baltimore, MD (USA), 16-18 Oct 1985). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The objective of the workshop was to define the water chemistry environments containing sulfur species that cause corrosion of alloy 600 steam generator tubing. Currently, indications of corrosion due to sulfur species are occurring in an increasing number of both domestic and foreign steam generators. The types of corrosive attack include intergranular corrosion (IGC) or intergranular attack (IGA), stress corrosion cracking (SCC), wastage, and pitting. Sulfate is the most likely cause of the corrosion. It has so many sources that its complete elimination from steam generators is very difficult. The presence and the identity of reduced sulfur species in steam generators has not been adequately established. Nor does the reduction of sulfate appear likely even under upset conditions. Nevertheless, the presence of sulfur on corroded alloy 600 surfaces suggests that reduced sulfur species may have been present locally during corrosive periods. Tests indicate that the sulfur can not be easily removed once present on the surface, which results in long-lasting accelerated corrosion.

27956 (EPRI-NP–6773-M) **BWR water chemistry impurity studies: Executive summary: Final report.** Ljungberg, L.G. (ABB Atom AB, Vaesteraas (Sweden)); Korhonen, S.; Renstroem, K.; Hofling, C.G.; Rebensdorff, B. Electric Power Research Inst., Palo Alto, CA (USA); ABB Atom AB, Vaesteraas (Sweden). c Mar 1990. 34p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Laboratory studies were made on the effect of water impurities on environmental cracking in simulated BWR water of stainless steel, low alloy steel and nickel-base alloys. Constant elongation rate tensile (CERT) tests were run in simulated normal water chemistry (NWC), hydrogen water chemistry (HWC), or start-up environment. Sulfate, chloride and copper with chloride added to the water at levels of a fraction of a ppM were found to be extremely deleterious to all kinds of materials except Type 316 NG. Other detrimental impurities were fluoride, silica and some organic acids, although acetic acid was beneficial. Nitrate and carbon dioxide were fairly inoccuous. Corrosion fatigue and constant load tests on compact tension specimens were run in simulated normal BWR water chemistry (NWC) or hydrogen water chemistry (HWC), without impurities or with added sulfate or carbon dioxide. For sensitized Type 304 SS in NWC, 0.1 ppM sulfate increased crack propagation rates in constant load tests by up to a factor of 100, and in fatigue tests up to a factor of 10. Also, cracking in Type 316 nuclear grade SS and Alloy 600 was enhanced, but to a smaller degree. Carbon dioxide was less detrimental than sulfate. 3 figs., 4 tabs.

27957 (SIEMENS-KWU-U9–414/89/010) **Examination of irradiated MOX test fuel rods with second-generation plutonium.** Goll, W. (Siemens AG Unternehmensbereich KWU, Erlangen (Germany, F.R.). Geschaeftsgebiet Brennelement-Technik); Porsch, D.; Schlemmer, F.; Braun, U. Siemens AG Unternehmensbereich KWU, Erlangen (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). May 1989. 61p. (In German). Contract BMFT AtT 7688/0. Order Number DE90780161. Available from NTIS (US Sales Only), PC A04/MF A01.

Performance and isotopic composition were analyzed as a function of burnup for UO_2/PuO_2 (MOX) second-generation recycled plutonium fuel by performing post-irradiation examinations at burnups up to 47 GWd/t (M). The MOX fuel rods - produced by using the ammonium-uranyl/plutonyl-carbonate (AUPuC) process - showed an operating performance comparable to that of MOX fuel rods with first-generation Pu, although fission gas release was considerably higher. A comparison of neutron physics results with the isotopic analyses confirmed that the fuel rod power histories and thus the reactivity pattern can be predicted with a high degree of accuracy. The nuclides relevant to neutron physics are described with sufficient accuracy. The data base for nuclides relevant to handling and storage is still too small to allow any general conclusions to be made. (orig.) With 19 refs., 10 tabs., 24 figs.

2102 Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled

Refer also to citation(s) 27705, 27706, 27708, 27954, 27955, 27957, 27979, 27982, 27987, 28006, 28036, 28037, 28038, 28039, 28041, 28042, 28043, 28045, 28046, 28051, 28053, 28054, 28055, 28058, 28059, 28062, 28063, 28064, 28065, 28068, 28070, 28071, 28072, 28073, 28074, 28084, 28527

27958 (AEEW-R–2350) **Achilles rig: Window sub-assemblies summary of development and operating experience.** Ryall, J.D. UKAEA Atomic Energy Establishment, Winfrith (UK). Engineering Div. Jul 1989. 6p. Order Number DE90625044. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Water droplet behaviour in a PWR core during the reflood phase of a Loss of Coolant Accident is studied in the ACHILLES Rig, using a two-colour, high speed photographic technique. Demountable window sub-assemblies were required for the shroud vessel which would remain leaktight throughout the repeated heating and quenching of reflood tests at pressures of up to 6 bar absolute, with maximum temperatures around 700°C. A design was developed which employed graphite packing to seal a vitreous silica window inside an austenitic stainless steel mount, with disc springs to maintain seal loading. Window sub-assemblies have been used very successfully in the ACHILLES Rig during 30 reflood tests at pressures of up to 4 bar absolute. No leakages have been observed and only minor problems have been experienced with some extrusion of graphite packing and one cracked window glass. It is concluded that no major modifications are required for continued operation. (author).

27959 (AEEW-R–2429) **A limited investigation of the sensitivity of the containment source term to certain primary circuit parameters under PWR severe accident conditions.** Chown, N.M.; Williams, D.A. UKAEA Atomic Energy Establishment, Winfrith (UK). Reactor Systems Analysis Div. Feb 1989. 205p. Order Number DE90625045. Available from NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS.

The sensitivity of the source term to the containment for a limited number of primary circuit parameters and phenomena has been investigated for three hypothetical PWR severe accident sequences. These sequences are: a large hot leg break with failure of electric power to engineered safety features (AB hot leg); a small cold leg break with failure of pumped ECCS (S_2D) and a transient initiated sequence with failure of secondary system relief valves, power conversion and auxiliary feedwater systems and loss of on and offsite power for at least 3 hours (TMLB'). (author).

27960 (AEEW-R–2476) **An analysis of semiscale MOD-2c S-FS-1 steam line break test using RELAP5/MOD2.** Rogers, J.M.

UKAEA Atomic Energy Establishment, Winfrith (UK). Reactor Systems Analysis Div. Mar 1989. 39p. Order Number DE90625046. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An analysis has been performed of Semiscale Steam Line Break Test, to support the validation of RELAP5/MOD2. Previous analyses of steam line breaks in the UK have made conservative assumptions about the lack of water carryover in the break discharge. This analysis utilises more sophisticated steam generator models attempting to follow the complex two phase phenomena that occur in this transient to obtain a more realistic assessment of its consequences. (author).

27961 (AEEW-R–2477) **An analysis of MB-2 100% steam line break test T-2013 using RELAP5/MOD2.** Rogers, J.M. UKAEA Atomic Energy Establishment, Winfrith (UK). Reactor Systems Analysis Div. Mar 1989. 27p. Order Number DE90625047. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This report presents RELAP5/MOD2 calculations of the 100% steam line break test T-2013 performed on the Westinghouse Model Boiler-2 facility (MB-2). The input deck uses a noding structure typical of what would be used for an integral rig or full plant study using the RELAP5/MOD2 code. Sensitivity calculations were performed for the break junction discharge coefficient and the separator drain line loss coefficient. (author).

27962 (BNL-NUREG–44440) **On the investigation of cracking in safety injection PWR lines due to thermal stratification.** Simos, N. (Brookhaven National Lab., Upton, NY (USA)); Reich, M.; Philippacopoulos, A.J.; Hartzmann, M. Nuclear Regulatory Commission, Washington, DC (USA). Mechanical Engineering Branch; Brookhaven National Lab., Upton, NY (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-900617–9: Pressure vessels and piping conference: be in tune for the 90's, Nashville, TN (USA), 17-21 Jun 1990). Order Number DE90009830. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Circumferential cracking in injection lines as well as feedwater lines has been observed in a number of PWRs around the world while its exact cause has been continuously sought through a number of independent investigations. The comprehensive conclusion of all studies is that the primary but not the only, cause of pipe failure is the thermal stratification phenomenon that occurs in pipes experiencing temperature differentials across their cross section. This phenomenon becomes more critical when it occurs in a cyclic manner and is associated with a number of transients as well as thermal shocks during each cycle. The resulting fatigue loading mechanism and its impact on the integrity of an auxiliary injection line is the focus of the present analysis. Thermal loadings which can simulate real temperature conditions are imposed on a 3-D finite element model of a portion of an injection line that has already experienced cracking. The induced thermal stress field is utilized to obtain excessive fatigue damage in the vicinity of the observed cracks. Finally, the impact of different levels and types of stratification as well as the geometric configuration of such lines on the pipe integrity is addressed. 12 refs., 12 figs.

27963 (CONF-900617–1) **Flow-induced vibration of component cooling water heat exchangers.** Yeh, Y.S. (Taiwan Power Co., Taipei (Taiwan). Nuclear Engineering Dept.); Chen, S.S. Argonne National Lab., IL (USA). [1990]. 45p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From Pressure vessels and piping conference: be in tune for the 90's; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE90003789. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper presents an evaluation of flow-induced vibration problems of component cooling water heat exchangers in one of Taipower's nuclear power stations. Specifically, it describes flow-induced vibration phenomena, tests to identify the excitation mechanisms, measurement of response characteristics, analyses to predict tube response and wear, various design alterations, and modifications of the original design. Several unique features associated with the heat exchangers are demonstrated, including energy-trapping modes, existence of tube-support-plate (TSP)-inactive modes, and fluidelastic instability of TSP-active and -inactive modes. On the basis of this evaluation, the difficulties and future research needs for the evaluation of heat exchangers are identified. 11 refs., 19 figs., 3 tabs.

27964 (EGG-EAST–8580) **Junction-based interphase drag and vertical stratification modifications for RELAP5/MOD3.** Riemke, R.A. EG and G Idaho, Inc., Idaho Falls, ID (USA). Jun 1989. 55p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009781. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report documents the junction-based interphase drag and the modifications to the vertical stratification model in RELAP5/MOD3. Background information, model description and solution method, coding changes, input requirements, output description, and assessment of these changes are described in the report. The use of the junction-based interphase drag improved the void fraction data comparison for the JAERI TPTF tests. Modifications to the vertical stratification model gave the model a better physical and numerical basis, but further refinements will be needed. 26 refs., 29 figs., 1 tab.

27965 (EGG-M–89008) **Natural circulation cooling in US pressurized water reactors.** Berta, V.T. (EG and G Idaho, Inc., Idaho Falls, ID (USA)); Wilson, G.E.; Boyack, B.E. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 10p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570;W-7405-ENG-36. (CONF-891208–30: Winter annual meeting of the American Society of Mechanical Engineers, San Francisco, CA (USA), 10-15 Dec 1989). Order Number DE90009763. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The research into the modes of, and heat removed by, natural circulation in PWR systems is reviewed for the purpose of determining the status of this method for off-nominal recovery procedures. The referenced information comes from all facets of the nuclear industry, both domestic and international. The information focuses on recent research (1986–1988); however, pre-1986 research is summarized and referenced. Particular attention is paid to the role of scaling in the experimental facilities and analytical tools. Three modes of natural-circulation cooling are covered: condensation. The conclusion of the review is that the new research reconfirms the pre-1986 conclusion that natural circulation is a viable means of decay heat removal. In addition, the new research sufficiently completes the acquisition of an appropriate experimental data base and the development of system codes to permit the design of valid plant recovery procedures incorporating all three modes of natural circulation. 48 refs., 1 fig., 3 tabs.

27966 (EPRI-NP–6626-M) **Belgian approach to steam generator tube plugging for primary water stress corrosion cracking: Final report.** Frederick, G. (TRACTEBEL, Brussels (Belgium)); Hernalsteen, P.; Dobbeni, D. Electric Power Research Inst., Palo Alto, CA (USA); Belgatom S.A., Brussels (Belgium). c Mar 1990. 23p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

For a number of years, three Belgian nuclear power plants have experienced primary water stress corrosion cracking (PWSCC) in the expansion transition area on a very large number of tubes. One of the plants has part depth rolled tubes and the others have full depth expansion. The report presents a review of the leakage experience associated with (PWSCC) in the Doel 2, Doel 3 and Tihange 2 Nuclear Power Plants and illustrates the type of cracking observed on pulled tubes from Doel 2 and Doel 3. The Belgian units operate with numerous through wall cracks without impairing the safety and the reliability of the plants. This is achieved by a safety approach based on the extensive use of advanced non-destructive examination (NDE) techniques and the development of new plugging limits. These limits are derived from a realistic interpretation of NRC Regulatory Guide 1.121 and are backed up by a substantial experimental program. The report summarizes the establishment of plugging limits for both axial and circumferential cracks in the roll transition area of full depth rolled tubes. The LABORELEC eddy current rotating probe (RPC) technology and associated crack sizing methodology are also described. 8 refs., 2 figs., 1 tab.

27967 (EPRI-NP–6731) **Guide to optimized replacement of equipment seals: Final report.** Gleason, J.F. (Wyle Labs.,

Huntsville, AL (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Wyle Labs., Huntsville, AL (USA). c Mar 1990. 109p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A reevaluation of current scheduled replacement intervals of polymeric seals in plant equipment can achieve significant benefits. Information is provided which has the potential for increasing replacement intervals based on better information on how seals have performed through unique nuclear industry tests to qualify equipment, improved elastomers and increased knowledge of the failure mechanisms and related performance. The research was performed by reviewing applications of elastomeric seals in nuclear plants and practice associated with defining seal replacement intervals in the nuclear power and other industries. Performance indicators and how they predict degradation of seals were evaluated. Guidelines and a flow chart for reevaluating seal replacement intervals are provided. 29 refs., 38 figs., 8 tabs.

27968 (EPRI-NP–6774) **Evaluation of sampling schemes for in-service inspection of steam generator tubing: Final report.** Hanlen, R.C. Electric Power Research Inst., Palo Alto, CA (USA); Pacific Northwest Lab., Richland, WA (USA). c Mar 1990. 104p. Sponsored by Electric Power Research Institute. DOE Contract AC06-76RL01830. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report is a follow-on of work initially sponsored by the US Nuclear Regulatory Commission (Bowen et al. 1989). The work presented here is funded by EPRI and is jointly sponsored by the Electric Power Research Institute (EPRI) and the US Nuclear Regulatory Commission (NRC). The goal of this research was to evaluate fourteen sampling schemes or plans. The main criterion used for evaluating plan performance was the effectiveness for sampling, detecting and plugging defective tubes. The performance criterion was evaluated across several choices of distributions of degraded/defective tubes, probability of detection (POD) curves and eddy-current sizing models. Conclusions from this study are dependent upon the tube defect distributions, sample size, and expansion rules considered. As degraded/defective tubes form "clusters" (i.e., maps 6A, 8A and 13A), the smaller sample sizes provide a capability of detecting and sizing defective tubes that approaches 100% inspection. When there is little or no clustering (i.e., maps 1A, 20 and 21), sample efficiency is approximately equal to the initial sample size taken. Thee is an indication (though not statistically significant) that the systematic sampling plans are better than the random sampling plans for equivalent initial sample size. There was no indication of an effect due to modifying the threshold value for the second stage expansion. The lack of an indication is likely due to the specific tube flaw sizes considered for the six tube maps. 1 ref., 11 figs., 19 tabs.

27969 (SAAS-Mitt–88-07) **Technical principles of functional tests of electric safety supply systems in nuclear power plants.** Staatliches Amt fuer Atomsicherheit und Strahlenschutz, Berlin (German Democratic Republic). 1988. 10p. (In German). Order Number DE90625057. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The technical principles are outlined of the functional test program applied in the GDR to electrical safety supply systems of nuclear power plants.

2103 Power Reactors, Nonbreeding, Graphite Moderated

Refer also to citation(s) 28087, 28398, 29042, 29043

2105 Power Reactors, Breeding

Refer also to citation(s) 27989, 28005, 28028, 28029, 28055, 28061, 28062, 28088

27970 (AEEW-R–2462) **Progress with modelling the fast reactor subassembly accident.** Buland, A.T.D.; Dobson, G.P.; George, M.A.; Macdougal, J.D.; Mason, A.; Thomas, H.A.; Timson, D.R.E.; Wall, D.N.; Williams, T.G. UKAEA Atomic Energy Establishment, Winfrith (UK). Safety and Engineering Science Div. Apr 1989. 140p. Available from H.M. Stationery Office, price Pound 14.00.

This report contains six papers presented to the International Liquid Metal Boiling Working Group, during its meeting from 27-29 September 1988 at AEE Winfrith. All the papers cover aspects of the fast reactor subassembly accident. (author).

27971 (CONF-900607–2) **An operator model-based filtering scheme.** Sawhney, R.S. (Tennessee Univ., Knoxville, TN (USA)); Dodds, H.L.; Schryer, J.C. Oak Ridge National Lab., TN (USA). [1990]. 5p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From Advances in human factors research on man-computer interactions: nuclear and beyond; Nashville, TN (USA); 10-15 Jun 1990. Order Number DE90006887. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper presents a diagnostic model developed at Oak Ridge National Laboratory (ORNL) for off-normal nuclear power plant events. The diagnostic model is intended to serve as an embedded module of a cognitive model of the human operator, one application of which could be to assist control room operators in correctly responding to off-normal events by providing a rapid and accurate assessment of alarm patterns and parameter trends. The sequential filter model is comprised of two distinct subsystems — an alarm analysis followed by an analysis of interpreted plant signals. During the alarm analysis phase, the alarm pattern is evaluated to generate hypotheses of possible initiating events in order of likelihood of occurrence. Each hypothesis is further evaluated through analysis of the current trends of state variables in order to validate/reject (in the form of increased/decreased certainty factor) the given hypothesis. 7 refs., 4 figs.

27972 (NRL-R–3034(W)) **A thermal-hydraulic test rig for advanced fast reactor fuel assemblies.** Rapier, A.C. UKAEA Northern Research Labs. Windscale, Seascale (UK). Mar 1989. 11p. Order Number DE90625089. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A new design of fast reactor fuel assemblies has been proposed in which the pins are supported in grids attached to the wrapper by flexible skirts. Coolant mixing is enhanced by the skirts diverting flow into the cluster of pins at each grid. There are insufficient empirical data available for the detailed design of the skirt or for the input to computer calculations of flow and heat transfer. A test rig to provide these data has been designed and built. (author).

2106 Power Reactors, Auxiliary, Mobile, Package, and Transportable

Refer also to citation(s) 27787, 27788, 28011, 28047, 28048, 28759

27973 (JAERI-M–89-216) **Experimental study on the critical heat flux in a varying acceleration field, (2): The measurement of critical heat flux under varying acceleration field, 1.** Kusunoki, Tsuyoshi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Otsuji. Tomoo; Ikawa, Hiromasa; Kurosawa, Akira; Iwahori, Koji; Yokomura, Takeyoshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 36p. (In Japanese). Order Number DE90777755. Available from NTIS (US Sales Only), PC A03/MF A01.

In establishing the thermohydraulic design method and the safety assessment of marine reactors, it is most important theme to understand how the varying acceleration induced by ship motion affect on critical heat flux. We made the joint study for the purpose clarifying quantitatively the decrease in CHF, due to varying acceleration. Experiment was carried out using R-113 as working fluid. From the experimental results, we can conclude: The conservative relation can be applied even under 0.5 MPa, that the ratio of CHF under the oscillating acceleration to CHF under stationary field is in propotion to a quarter power of the minimum gravitational acceleration. The frequency response functions of flow rate and exit void fraction to acceleration oscillation were obtained. It is indicated that acceleration oscillation influences void fraction significantly at certain section of flow region. (author).

27974 (SAND–89-1064C) **Experimental demonstration of the MIT-SNL [Massachusetts Institute of Technology-Sandia**

National Laboratories] period-generated minimum time control laws for rapid increases of reactor power from subcritical conditions. Bernard, J.A. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Nuclear Reactor Lab.); Kwok, K.S.; Washio, T.; Wyant, F.J.; Thome, F.V. Sandia National Labs., Albuquerque, NM (USA). [1990]. 32p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC04-76DP00789. (CONF-890103–13: 6. symposium on space nuclear power systems, Albuquerque, NM (USA), 9-12 Jan 1989). Order Number DE90009327. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Use of the MIT-SNL Period-Generated Minimum Time Control Laws for the automated increase of neutronic power from subcritical conditions has recently been demonstrated. The use of these laws is advantageous because they provide the speed at which a control device should be withdrawn in order to generate a specified period. Two strategies were investigated. The first was the direct use of the MIT-SNL laws for the entire transient, startup plus operation at power. The second was to add reactivity at a constant rate until criticality was achieved and then to transfer control to the MIT-SNL laws. Each was evaluated by both simulation and actual experiment under conditions of closed-loop digital control on the Annular Core Research Reactor that is operated by the Sandia National Laboratories. Both approaches were shown to be feasible. The former has the advantage that the power profile will be known during the startup. Its drawback is that an excessively high rate of reactivity change may be needed to initiate the transient. 16 refs., 9 figs.

27975 DIPS power conversion cycle selection. Stadnik, A.G. (Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.). pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

This paper presents the results of the dynamic power conversion cycle selection process conducted by the Rocketdyne Division of Rockwell International as part of the Dynamic Isotope Power Subsystem (DIPS) Program, sponsored by the U.S. Department of Energy (DOE). Rocketdyne is under contract with DOE for the DIPS Program. The objective of the DIPS Program is to demonstrate the technology necessary to provide dynamic radioisotope space electrical power systems in the 1 to 10 kWe range to support evolving military and civilian missions in the early 1990s and beyond. Selecting the most appropriate DIPS power conversion cycle that would support this objective was an integral step in this process. The closed Brayton cycle was selected as the preferred power conversion cycle for the DIPS Program based on an evaluation of several key areas concerning spacecraft power systems performance.

27976 Application of cermet fueled reactors to multimegawatt space power systems. Kruger, G. B. (General Electric Co., San Jose, CA (USA). Astro Space Div.); Lobach, J. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989). Paper 899193.

The need to supply multimegawatt (MMW) electrical power for short durations is anticipated for the space weapon systems in the Strategic Defense Initiative (SDI) applications. The use of a nuclear reactor as the heat source to drive a turbine-alternator power converter is one of the lightest weight MMW space power systems available. Under a contract with the Department of Energy (DOE), GE has designed an open-cycle, burst power system. In this paper, the open cycle, Multimegawatt Burst Power System is emphasized. The closed Brayton cycle, Rankine cycle and Rocket Propulsion applications are also discussed to illustrate the applicability of cermet fuel to meet the needs of a broad range of space power applications. The Cermet Fuel Fast Spectrum Reactor provides an attractive, flexible space power system which has the potential to meet the needs of broad range of space power applications.

27977 Conceptual design of a Category III multimegawatt space nuclear power system. Feddersen, R.E. (Grumman Corp., Bethpage, NY (USA). Space Systems Div.); Coiner, J.R. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989). Paper 899551.

As part of the Strategic Defense Initiative Office's Space Power Programs, the Department of Energy (DOE) is directing a multiyear, multi-phase effort known as the Multimegawatt Space Reactor Project (MMW). Six companies were winners of Phase I contracts. In the Phase I effort, completed in February 1989, the six prime contractors conducted the trade-off studies and analyses required to arrive at MMW conceptual designs in three categories. The Category I concept is capable of delivering 10's of megawatts of electric power (MW_e) for 100's of seconds with effluents permitted. Category II has the same basic requirements as Category I, but no effluents are permitted. Category III is the same as Category I, but must produce 100's of MW_e. This paper presents a summary of some of the results of the Category III conceptual design studies. Design requirements are reviewed, an overall system description is presented with major components identified and primary state points quantified, followed by a discussion of this concept's unique particle bed reactor (PBR).

2107 Regulation and Licensing

Refer also to citation(s) 28011, 28048, 28053, 28055, 28066

27978 (EPRI-NP–6790-M) **Evaluation of upper-shelf toughness requirements for reactor pressure vessels: Final report.** Gamble, R.M. (NOVETECH Corp., Rockville, MD (USA)); Zahoor, A.; Hiser, A.; Ernst, H.A.; Pollitz, E.T. Electric Power Research Inst., Palo Alto, CA (USA); NOVETECH Corp., Rockville, MD (USA); Materials Engineering Associates, Inc., Lanham, MD (USA); Georgia Inst. of Tech., Atlanta, GA (USA). c Apr 1990. 22p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This work assesses and applies the criteria recommended by the ASME Subgroup on Evaluation Standards for the evaluation of reactor pressure vessel beltline materials having upper shelf Charpy energies less than 50 ft-lbs. The assessment included comparison of the upper shelf energies required by the criteria recommended for Service Level A and B conditions and criteria proposed for evaluation of postulated Service Level C and D events. The criteria recommended for Service Level A and B conditions was used to evaluate Linde 80 weld material. 9 refs., 4 figs.

27979 (NUREG–0090-Vol.12-No.4) **Report to Congress on abnormal occurrences, October–December 1989.** Nuclear Regulatory Commission, Washington, DC (USA). Office for Analysis and Evaluation of Operational Data. Mar 1990. 20p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO - OSTI.

Section 208 of the Energy Reorganization Act of 1974 identifies an abnormal occurrence as an unscheduled incident or event that the Nuclear Regulatory Commission determines to be significant from the standpoint of public health or safety and requires a quarterly report of such events to be made to Congress. This report covers the period from October 1 through December 31, 1989. For this reporting period, there were three abnormal occurrences, none involving a licensed nuclear power plant. Two of the abnormal occurrences involved nuclear material licensees and are described in detail under other NRC-issued licenses. The first involved a medical diagnostic misadministration and the second involved a medical therapy misadministration. The third abnormal occurrence was reported by an Agreement State (Louisiana) and involved an overexposure to an industrial radiographer. The report also contains information that updates a previously reported abnormal occurrence.

27980 (NUREG–0304-Vol.14-No.4) **Regulatory and technical reports (Abstract Index Journal): Annual compilation for 1989: Volume 14, No. 4.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Freedom of Information and Publications Services. Mar 1990. 145p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A07/MF A01 - GPO - OSTI.

This journal includes all formal reports in the NUREG series prepared by the NRC staff and contractors; proceedings of conferences and workshops; as well as international agreement reports. The entries in this compilation are indexed for access by title and abstract, secondary report number, personal author, subject, NRC organization for staff and international agreements, international organization, and licensed facility.

27981 (NUREG–0325-Rev.13) **US Nuclear Regulatory Commission functional organization charts: Revision 13.** Nuclear Regulatory Commission, Washington, DC (USA). Office of Personnel. 1 Apr 1990. 58p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

Functional organization charts for the US Nuclear Regulatory Commission offices, divisions, and branches are presented in this document.

27982 (NUREG–0386-Digest-5-Rev.5) **United States Nuclear Regulatory Commission staff practice and procedure digest: Commission, Appeal Board and Licensing Board decisions, July 1, 1972–September 30, 1989: Revision 5.** Nuclear Regulatory Commission, Washington, DC (USA). Office of the General Counsel. Mar 1990. 673p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A99/MF A01 - GPO; OSTI; INIS.

This document contains procedures for review by US Nuclear Regulatory Commission for reviewing and deciding on matters pertaining to nuclear power plant licensing. Also, contained within the document are decisions the Commission has made between July 1972 to September 1989. (F.S.D.)

27983 (NUREG–0540-Vol.2-No.12) **Title list of documents made publicly available, December 1–31, 1989: Volume 2, No. 12.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Freedom of Information and Publications Services. Apr 1990. 229p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A11/MF A01 - GPO; OSTI; INIS.

The Title List of Documents Made Publicly Available is a monthly publication. It contains descriptions of the information received and generated by the US Nuclear Regulatory Commission (NRC). This information includes (1) docketed material associated with civilian nuclear power plants and other uses of radioactive materials and (2) nondocketed material received and generated by NRC pertinent to its role as a regulatory agency. As used here, docketed does not refer to Court dockets; it refers to the system by which NRC maintains its regulatory records. This series of documents is indexed by a Personal Author Index, a Corporate Source Index, and a Report Number Index. The docketed information contained in the Title List includes the information formerly issued through the Department of Energy publication Power Reactor Docket Information, last published in January 1979. Microfiche of the docketed information listed in the Title List is available for sale on a subscription basis from the National Technical Information Service (NTIS). See NOTES at the end of the Preface for the complete NTIS address. We encourage your comments, criticisms, and suggestions. In particular, if there are title descriptions that are not meaningful, please let us know so that we can correct the data base. Insofar as possible, we would like this document to be a valuable part of your reference material.

27984 (NUREG–0750-Vol.30-No.6) **Nuclear Regulatory Commission Issuances, December 1989: Volume 30, No. 6.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Freedom of Information and Publications Services. Dec 1989. 103p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A06/MF A01 - GPO; OSTI; INIS.

This report includes the issuances received during the specified period from the Commission (CLI), the Atomic Safety and Licensing Appeal Boards (ALAB), the Atomic Safety and Licensing Boards (LBP), the Administrative Law Judge (ALJ), the Directors' Decisions (DD), and the Denials of Petitions for Rulemaking (DPRM).

27985 (NUREG–0750-Vol.31-No.1) **Nuclear Regulatory Commission Issuances: Volume 31, No. 1.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Freedom of Information and Publications Services. Jan 1990. 130p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

This report includes the issuances received during the specified period from the Commission (CLI), the Atomic Safety And Licensing Appeal Boards (ALAB), the Atomic Safety and Licensing Boards (LBP), the Administrative Law Judge (ALJ), the Directors' Decisions (DD), and the Denials of Petitions for Rulemaking (DPRM).

27986 (NUREG/CP–0108) **Proceedings of the public workshop on nuclear power plant license renewal.** Hughes, A.A. (Mitre Corp., McLean, VA (USA)); Ligon, D.M.; Seth, S.S. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Safety Issue Resolution; Mitre Corp., McLean, VA (USA). Apr 1990. 77p. Sponsored by Nuclear Regulatory Commission. (MTR–90W00013;CONF-8911183–Summ.: Public workshop on nuclear power plant license renewal, Reston, VA (USA), 13-14 Nov 1989). Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

On 13 October 1989, the US Nuclear Regulatory Commission (NRC) issued an Advance Notice of Proposed Rulemaking on nuclear power plant license renewal. The notice presented the NRC's preliminary regulatory philosophy and approach for developing license renewal regulations, and solicited comments on a number of technical and policy issues. It also announced plans for a public workshop to discuss the issues and to receive comments and information. Representatives from 89 organizations attended the workshop held on 13–14 November 1989, in Reston, Virginia. Subsequently, 12 organizations submitted written comments to the NRC. This report provides a summary of both workshop and written comments.

27987 (NUREG/CR–2000-Vol.9-No.2) **Licensee event report (LER) compilation: For month of February 1990.** Nuclear Regulatory Commission, Washington, DC (USA). Office for Analysis and Evaluation of Operational Data; Oak Ridge National Lab., TN (USA). Mar 1990. 113p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL/NSIC–200-Vol.9-No.2). Available from NTIS, PC A06/MF A01; OSTI; INIS.

This monthly report contains Licensee Event Report (LER) operational information that was processed into the LER data file of the Nuclear Safety Information Center (NSIC) during the one month period identified on the cover of the document. The LERs, from which this information is derived, are submitted to the Nuclear Regulatory Commission (NRC) by nuclear power plant licensees in accordance with federal regulations. Procedures for LER reporting for revisions to those events occurring prior to 1984 are described in NRC Regulatory Guide 1.16 and NUREG-0161, Instructions for Preparation of Data Entry Sheets for Licensee Event Reports. For those events occurring on and after January 1, 1984, LERs are being submitted in accordance with the revised rule contained in Title 10 Part 50.73 of the Code of Federal Regulations (10 CFR 50.73 — Licensee Event Report System) which was published in the Federal Register (Vol. 48, No. 144) on July 26, 1983. NUREG-1022, Licensee Event Report System — description of Systems and Guidelines for Reporting, provides supporting guidance and information on the revised LER rule.

22 NUCLEAR REACTOR TECHNOLOGY

Refer also to citation(s) 28149, 29852

2201 Theory and Calculation

Refer also to citation(s) 28009, 28085, 28086, 28088, 29886, 29887

27988 (CONF-900608–13) **Expanded and applied sixteen neutron-energy-group cross-section library.** Hopper, C.M.; Renier, J.P. Oak Ridge National Lab., TN (USA). [1990]. 10p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From American Nuclear Society annual meeting; Nashville, TN (USA); 10-15 Jun 1990. Order Number DE90008752. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The purpose of this work was fivefold: to develop an expanded neutron cross-section library containing approximately 1200

cross-section sets with the Hansen-Roach (H-R) sixteen neutron-energy-group structure; to provide an enhanced computational tool on a personal computer for criticality calculations; to provide consistent values of the effective scattering cross sections (sigma-s) for each set of the expanded H-R library, for selecting the resonance self-shielded cross sections (sigma-p); to develop a consistent technique for calculating sigma-p to select and apply specific self-shielded cross-section sets; and to apply the cross sections and the selection technique to a wide variety of criticality calculational benchmarks. 18 refs., 1 fig.

27989 (CTA-IEAv-RP–041/89) **Utilization of transmission probabilities in the calculation of unit-cell by the interface-current method.** Queiroz Bogado Leite, S. de. Centro Tecnico Aeroespacial, Sao Jose dos Campos, SP (Brazil). Inst. de Estudos Avancados. Oct 1989. 22p. (In Portuguese). Order Number DE90624974. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A widely used but otherwise physically incorrect assumption in unit-cell calculations by the method of interface currents in cylindrical or spherical geometries, is that of that of isotropic fluxes at the surfaces of the cell annular regions, when computing transmission probabilities. In this work, new interface-current relations are developed without making use of this assumption and the effects on calculated integral parameters are shown for an idealized unit-cell example. (author).

27990 (CTA-IEAv-RP–045/89) **Numerical determination of transmission probabilities in cylindrical geometry.** Queiroz Bogado Leite, S. de. Centro Tecnico Aeroespacial, Sao Jose dos Campos, SP (Brazil). Inst. de Estudos Avancados. Nov 1989. 23p. (In Portuguese). Order Number DE90624975. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Efficient methods for numerical calculation of transmission probabilities in cylindrical geometry are presented. Relative errors of the order of 10^{-5} or smaller are obtained using analytical solutions and low order quadrature integration schemes. (author).

27991 (EGG-NE–8863) **TOODEE: A two-dimensional, time-dependent heat conduction program.** Sackett, B.J.; Ambrosek, R.G. EG and G Idaho, Inc., Idaho Falls, ID (USA). Jan 1990. 131p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009631. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

As originally compiled by John A. McClure.

TOODEE is a two-dimensional, time-dependent heat conduction computer program written in FORTRAN. This program is suitable for investigating general transient and/or steady-state problems. Typical of (but not limited to) the type of problems for which the program has been used are the calculation of temperature distributions in reactor fuel elements during power excursions. The mesh for the program is formed by variably spaced orthogonal curves in either slab or cylindrical geometry. The cylindrical geometry may be either axisymmetric, with space variables R-Z, or polar, with space variables R-θ. Conditions to be specified independently at each boundary are either surface temperatures or heat transfer coefficients and either exterior temperatures of flow rates. Materials and coolant properties required in the program are evaluated from FORTRAN arithmetic functions supplied by the user. These properties may be time and/or temperature dependent. In addition, nonisotropic thermal conductivities and expansion coefficients may be defined. Phase changes are permitted in all materials except coolants. 6 refs.

27992 (JAERI-M–89-201) **JAERI contribution to the second NEACRP benchmark calculation on High Conversion Light Water Reactor lattices.** Okumura, Keisuke (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Ishiguro, Yukio; Tanaka, Ken-ichi; Jeong, Chang-Joon. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 154p. Order Number DE90777734. Available from NTIS (US Sales Only), PC A08/MF A01.

It was determined to perform the second NEACRP benchmark calculation on High Conversion Light Water Reactor (HCLWR) lattices at the 31st NEACRP meeting on October, 1988. The object was to clarify the physics problems induced in the data and method on HCLWR lattice analyses and also to obtain the reference solutions for deterministic codes by using continuous energy Monte Carlo codes. In the new problems, the analysis for the PROTEUS-LWHCR experiments were added. JAERI participated in this benchmark comparison by use of the VIM code (Monte Carlo method) and the SRAC code (collision probability method) with the libraries based on the JENDL-2 file. In this report, all of the calculated results are summarized. Some additional investigation will be also shown on resonance treatment and geometrical modelling relevant to the benchmark calculation. (author).

27993 (ORNL/M–1120) **Standard problem exercise on criticality codes for dissolving fissile oxides in acids.** Whitesides, G.E. (ed.). Oak Ridge National Lab., TN (USA). Apr 1990. 142p. DOE Contract AC05-84OR21400. (NEACRP-L–306). Order Number DE90009444. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; GPO Dep.

This study presents the results of an attempt to determine the validity of several computational methods for fissile systems in which fissile material in solid form is surrounded by fissile material in solution. The particular systems for which this is applicable are (1) transport accidents in which the cladding of the fissile material is breached, (2) TMI-2-type reactor accidents, and more commonly (3) in the dissolution of fuel elements in acid. In order to validate a computational method for performing nuclear criticality safety calculations for a particular application, it is necessary to determine the ability of the method to reproduce experimental data for systems that have similar neutronic, material, and geometric properties. A series of eighteen experimentally critical systems were chosen for the validation procedure. The set of experiments were not as complete as desirable because of the lack of applicable experimental data. In addition, several experimental data sets suffer from inconsistencies that led the Working Group to be suspect of some essential parameters. Based on the results of this study, it was concluded that the systems being examined required more rigor in a computational method than was required for the systems that the Working Group had studied previously. This evaluation resulted in the conclusion that one method, the NITAWL cross-section processing program that had been successfully used in our previous studies, was inadequate for this type of system. Several other methods were demonstrated to be valid for fissile solid/fissile solution systems.

2202 Components and Accessories

Refer also to citation(s) 27753, 27978, 28075, 28083, 28372

27994 (AEEW-R–2480) **Experiments at AEE Winfrith on the penetration of molten fuel into pin arrays and tubes.** Miller, K. (CEGB Berkeley Nuclear Labs, Gloucester (United Kingdom)); Tattersall, R.B.; Maddison, R.J. UKAEA Atomic Energy Establishment, Winfrith (UK). Safety and Engineering Science Div. Mar 1989. 34p. Order Number DE90624977. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A series of experiments is described which studied the penetration of structures by molten UO_2. The UO_2 was produced by ignition of a U/MoO_3 thermite which yielded a molten mixture of UO_2 and Mo at a temperature of about 3600K. This mixture was injected into pin arrays and tubes with driving pressures ranging from zero (a gravity pour) to 2MPa. (author).

27995 (CEGB-ESTD/L–0031/R89) **A mathematical model for erosion-corrosion downstream of an orifice.** Thomas, R.M. Central Electricity Research Labs., Leatherhead (UK). Aug 1989. 27p. Order Number DE90624978. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In certain types of nuclear plant, the internal surfaces of the steel high-pressure boiler tubes become covered with magnetite. This normal growth of protective magnetite may, in unfavourable circumstances, be replaced by rapid attack on the tube wall. Particularly at risk are the regions downstream of the orifice plates commonly fitted near the boiler inlet. An attempt is made to construct a mathematical model for this erosion-corrosion which is considerably more complete than those available hitherto. A systematic synthesis is developed of the various aspects of the phenomenon,

namely the mechanism of the topotactic oxidation at the interface between magnetite and metal, the kinetics of the electrode reactions at the magnetite/solution interface, the thermodynamics of magnetite solubility and the calculation of mass transfer in solution. With one choice of parameters and some simplification, the treatment reduces to the original theory of Bignold. (author).

27996 (CEGB-RD/B–6217/R89) **Development of a leak-before break procedure for pressurised components.** Langston, D.B. Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs. May 1989. 8p. Order Number DE90624979. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

For pressurised components there is an increasing interest in the use of leak-before-break arguments to show that defects will behave in a "failsafe" manner by growing in such a way as to cause a detectable leak before a disruptive failure of the pressure boundary can occur. The CEGB operates a wide variety of plant and has recognised the need for a flexible leak-before-break procedure which can be applied in a variety of different situations including part-through defects. This paper describes the development of such a procedure and discusses some of the key aspects of the leak-before-break procedure. (author).

27997 (CEGB-RD/B–6222/R89) **Pressure vessel rupture within a chamber: the pressure history on the chamber wall.** Baum, M.R. Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs. Apr 1989. 21p. Order Number DE90624980. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Generally there is a large number of pressure vessels containing high pressure gas on power stations and chemical plant. In many instances, particularly on power plant, these vessels are within the main building. If a pressure vessel were to fail, the surrounding structures would be exposed to blast loads and the forces resulting from jets of fluid issuing from the breached vessel. In the case where the vessel is in a relatively closed chamber there would also be a general overpressurisation of the chamber. At the design stage it is therefore essential to demonstrate that the plant could be safely shut down in the event of a pressure vessel failure, that is, it must be shown that the chamber will not collapse thus putting the building at risk or hazarding equipment essential for a safe shut down. Such an assessment requires the loads applied to the chamber walls, roof, etc. to be known. (author).

27998 (CEGB-RD/L–3442/R88) **A theoretical analysis of flow through the nucleating stage in a low pressure steam turbine.** Skillings, S.A.; Walters, P.T.; Jackson, R. Central Electricity Research Labs., Leatherhead (UK). Jan 1989. 20p. Order Number DE90624981. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In order to improve steam turbine efficiency and reliability, the phenomena associated with the formation and growth of water droplets must be understood. This report describes a theoretical investigation into flow behaviour in the nucleating stage, where the predictions of a one-dimensional theory are compared with measured turbine data. Results indicate that droplet sizes predicted by homogeneous condensation theory cannot be reconciled with measurements unless fluctuating shock waves arise. Heterogeneous effects and flow turbulence are also discussed along with their implications for the condensation process. (author).

27999 (EPRI-NP–6703-M) **Effect of different thermal treatments on the corrosion resistance of alloy 690 tubing: Final report.** Crum, J.R. (Inco Alloys International, Inc., Huntington, WV (USA)); Heck, K.A.; Angeliu, T.M. Electric Power Research Inst., Palo Alto, CA (USA); Inco Alloys International, Inc., Huntington, WV (USA). c Mar 1990. 17p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

A comparison of the carbide precipitation characteristics and corrosion resistance of commercially produced alloy 690 steam generator tubing from various sources, with different thermal treatments, was made. Four thermal treatments within the ranges of 700–720°C (1292–1328°F)/5–5.75 hrs and 871–927°C (1600–1700°F)/10 min were compared to one another and to two as-mill annealed tubes. All tubes were characterized with respect to chemical composition, mechanical properties, and microstructure. Overall carbide precipitation was determined by etching with phosphoric acid/nital, bromine-methanol and glyceregia/oxalic etchants. Scanning transmission electron microscope analysis provided detailed chromium depletion profiles across the grain boundary and carbide composition. Nitric acid intergranular attack (IGA) tests were also conducted. C-ring stress corrosion cracking (SCC) tests, with stresses above the yield strength were then conducted in 350°C (662°F) deaerated 1, 10, and 50% NaOH and unstressed IGA tests were conducted in a NaOH-Na_2SO_4–Fe_3O_4–Fe_2O_3 environment, also at 350°C (662°F). 2 tabs.

28000 (KURRI-TR–327) **Proceedings of the workshop on the cooling of high-performance reactors.** Miyazaki, Keiji (Osaka Univ., Suita (Japan). Faculty of Engineering); Nishihara, Hideaki; Mishima, Kaichiro (eds.). Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. Jan 1990. 170p. (In Japanese). (CONF-8901187–: Workshop on the cooling of high-performance reactors, Kumatori (Japan), 17-18 Jan 1989). Order Number DE90777871. Available from NTIS (US Sales Only), PC A08/MF A01.

This issue is the collection of the papers presented at the title meeting. The 9 of the presented papers are indexed individually. (J.P.N.).

28001 (NUREG/CR–5493) **Influence of fluence rate on radiation-induced mechanical property changes in reactor pressure vessel steels: Final report on exploratory experiments.** Hawthorne, J.R. (Materials Engineering Associates, Inc., Lanham, MD (USA)); Hiser, A.L. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Materials Engineering Associates, Inc., Lanham, MD (USA). Mar 1990. 342p. Sponsored by Nuclear Regulatory Commission. (MEA–2376). Available from NTIS, PC A15/MF A01 - GPO; OSTI; INIS.

This report describes a set of experiments undertaken using a 2 MW test reactor, the UBR, to qualify the significance of fluence rate to the extent of embrittlement produced in reactor pressure vessel steels at their service temperature. The test materials included two reference plates (A 302-B, A 533-B steel) and two submerged arc weld deposits (Linde 80, Linde 0091 welding fluxes). Charpy-V (C_v), tension and 0.5T-CT compact specimens were employed for notch ductility, strength and fracture toughness (J-R curve) determinations, respectively. Target fluence rates were 8×10^{10}, 6×10^{11} and 9×10^{12} n/cm^2 $-s^{-1}$. Specimen fluences ranged from 0.5 to 3.8×10^{19} n/cm^2, E > 1 MeV. The data describe a fluence-rate effect which may extend to power reactor surveillance as well as test reactor facilities now in use. The dependence of embrittlement sensitivity on fluence rate appears to differ for plate and weld deposit materials. Relatively good agreement in fluence-rate effects definition was observed among the three test methods. 52 figs., 4 tabs.

28002 (NUREG/CR–5494) **Correlation of irradiation-induced transition temperature increases from C_v and K_{Jc}/K_{Ic} data: Final report.** Hiser, A.L. (Materials Engineering Associates, Inc., Lanham, MD (USA)). Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Materials Engineering Associates, Inc., Lanham, MD (USA). Mar 1990. 223p. Sponsored by Nuclear Regulatory Commission. (MEA–2377). Available from NTIS, PC A10/MF A01 - GPO; OSTI; INIS.

Reactor pressure vessel (RPV) surveillance capsules contain Charpy-V (C_v) specimens, but many do not contain fracture toughness specimens; accordingly, the radiation-induced shift (increase) in the brittle-to-ductile transition region (ΔT) is based upon the ΔT determined from notch ductility (C_v) tests. Since the ASME K_{Ic} and K_{IR} reference fracture toughness curves are shifted by the ΔT from C_v, assurance that this ΔT does not underestimate ΔT associated with the actual irradiated fracture toughness is required to provide confidence that safety margins do not fall below assumed levels. To assess this behavior, comparisons of ΔT's defined by elastic-plastic fracture toughness and C_v tests have been made using data from RPV base and weld metals in which irradiations were made under test reactor conditions. Using "as-measure" fracture toughness values (K_{Jc}), average comparisons between $\Delta T(C_v)$ and $\Delta T(K_{Jc})$ are: (a) All data: $\Delta T(K_{Jc}$ @ 100 MPa$\sqrt{m})$ = $\Delta T(C_v$ @ 41 J) +10°C; (b) Plates only: $\Delta T(K_{Jc}$ @ 100 MPa$\sqrt{m})$ = $\Delta T(C_v$ @ 41 J) +15°C; and (c) Welds only: $\Delta T(K_{Jc}$ @ 100 MPa$\sqrt{m})$ = $\Delta T(C_v$ @ 41 J) −1°C.

Fluence rate is found to have no significant effect on the relationship between $\Delta T(C_v)$ and $\Delta T(K_{Ic})$. 12 refs., 12 figs., 5 tabs.

2203 Fuel Elements

Refer also to citation(s) 28063, 28064, 28065

28003 (JAERI-M–89-186) **Post irradiation examinations of uranium-plutonium mixed carbide fuels irradiated at medium linear power rate.** Iwai, Takashi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Sasayama, Tatsuo; Aizawa, Sakuei; Kawasaki, Kohsei; Aizawa, Masao; Handa, Muneo; Maeda, Atsushi. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 113p. (In Japanese). Order Number DE90777737. Available from NTIS (US Sales Only), PC A06/MF A01.

Two pins containing uranium-plutonium mixed carbide fuels which are different in stoichiometry, i.e. $(U,Pu)C_{1.0}$ and $(U,Pu)C_{1.1}$, were constructed into a capsule, ICF-47H, and were irradiated in JRR-2 up to 1.5 at.% burnup at linear power rate of 640 W/cm. The irradiated capsule cooled for about ten months was transferred to the Reactor Fuel Examination Facility where the non-destructive examination of the fuel pins in the β-γ cells and the destructive one in the α-γ inert gas atmosphere cells were carried out. Dimensional changes of the fuel pins were not observed because of the low density of the fuel pellets and the low burnup. The fission gas release rates were 9.4% both from $(U,Pu)C_{1.0}$ and $(U,Pu)C_{1.1}$ fuels, which was governed by the diffusion of the gas atoms. The release rates are large relatively as the density of the fuel pellets is low (81≈82% T.D. after irradiation) and the open porosity of the fuel pellets is high, about 11%. The numbers of pores at the center of the fuel pellet decreased remarkably after irradiation. The corrosion at the inner side of the cladding which was caused by the chemical interaction between the fuel pellets and claddings was observed at the $(U,Pu)C_{1.1}$ fuel pin. (author).

28004 (JAERI-M–89-199) **Analysis of effect of variation of gas size in buckled cladding on temperature and heat flux distribution of fuel rod.** Hoshiya, Taiji (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Someya, Hiroyuki; Yamaguchi, Noboru; Harayama, Yasuo. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 42p. (In Japanese). Order Number DE90777739. Available from NTIS (US Sales Only), PC A03/MF A01.

Gap size will variate along the periphery of a pellet in a fuel rod, when the pellet shifted one side within the cladding, fuel cladding had ovality of buckling took place. Expressions were analytically derived to estimate effects of local gap conductance due to gap size variation on the temperature and heat flux in the fuel rod. It was shown that errors in temperature estimation decreased to small values when these expressions are applied to a UO_2 fuel rod with a small thermal conductivity and that those, on the other hand, increased to large ones when applied to a UC fuel rod with a large thermal conductivity. Derived expressions can be used in design and safety evaluation for UO_2-zircaloy fuel rods in light water reactors. The average gap conductance was represented quantitatively by those expressions when gap size variated along the periphery of a pellet or the pellet shifted one side within the cladding in a fuel rod. It was found from derived expressions that the average gap conductance was regarded as the nominal gap conductance at axisymmetrical gap size, even if the center of pellet shifted from the center of cladding. This provides us with the logical grounds that assuming a fuel-cladding location to be axisymmetric, no problem takes place for evaluating the temperature of the fuel rod using conventional methods in thermal design calculations of the fuel rod. (author).

2204 Control Systems

Refer also to citation(s) 28032, 28050, 28069

28005 (CONF-900607–1) **A display to support knowledge based behavior.** Lindsay, R.W. Argonne National Lab., IL (USA). [1990]. 8p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From Advances in human factors research on man-computer interactions: nuclear and beyond; Nashville, TN (USA); 10-15 Jun 1990. Order Number DE90005661. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A computerized display has been created for the Experimental Breeder Reactor II (EBR-II) that incorporates information from plant sensors in a thermodynamic model display. The display is designed to provide an operator with an overall view of the plant process as a heat engine. The thermodynamics of the plant are depicted through the use of ionic figures, animated by plant signals, that are related to the major plant components and systems such as the reactor, intermediate heat exchanger, secondary system, evaporators, superheaters, steam system, steam drum, and turbine-generator. This display supports knowledge based reasoning for the operator as well as providing the traditional rule and skill based behavior, and includes side benefits such a inherent signal validation.

28006 (EGG-M–89492) **Insights into complex human performance.** Hahn, H.A.; Blackman, H.S. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 7p. Sponsored by U.S. Department of Defense; U.S. DOE Nuclear Energy; Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (CONF-9006115–1: American Nuclear Society topical meeting on human factors, Snowbird, UT (USA), 10-14 Jun 1990). Order Number DE90006957. Available from NTIS, PC A02/MF A01 - OSTI.

A research program was implemented to investigate the applicability of verbal protocol analysis to identify operator strategies for task performance and to assess how well strategies further define the performance of humans in complex systems. This research was conducted in two environments: control rooms of nuclear power plants and cockpits of civilian aircraft. Results are presented regarding the specific technique of applying verbal protocol methods as well as the importance of strategies in human performance in complex systems. 4 refs., 2 figs.

28007 (EPRI-GS/NP–6670, pp. 8.15-8.30) **Plant control using embedded predictive models.** Godbole, S.S. (Babcock and Wilcox, Lynchburg, VA (USA)); Gabler, W.E.; Eschbach, S.L. Electric Power Research Inst., Palo Alto, CA (USA); TRAX Corp., Lynchburg, VA (USA); Duke Power Co., Charlotte, NC (USA). Feb 1990. DOE Contract AC03-86SF16567. (CONF-8806165–: 1. EPRI conference on power plant simulators and modeling, Charlotte, NC (USA), 15-17 Jun 1988). In *Proceedings: 1988 conference on power plant simulators and modeling.* Order Number DE90008689. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

B and W recently undertook the design of an advanced light water reactor control system. A concept new to nuclear steam system (NSS) control was developed. The concept, which is called the Predictor-Corrector, uses mathematical models of portions of the controlled NSS to calculate, at various levels within the system, demand and control element position signals necessary to satisfy electrical demand. The models give the control system the ability to reduce overcooling and undercooling of the reactor coolant system during transients and upsets. Two types of mathematical models were developed for use in designing and testing the control system. One model was a conventional, comprehensive NSS model that responds to control system outputs and calculates the resultant changes in plant variables that are then used as inputs to the control system. Two other models, embedded in the control system, were less conventional, inverse models. These models accept as inputs plant variables, equipment states, and demand signals and predict plant operating conditions and control element states that will satisfy the demands. This paper reports preliminary results of closed-loop Reactor Coolant (RC) pump trip and normal load reduction testing of the advanced concept. Results of additional transient testing, and of open and closed loop stability analyses will be reported as they are available.

28008 (JAERI-M–89-195) **Verification of plant dynamics analysis code for HTTR 'ASURA'.** Fujimoto, Nozomu (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Nakagawa, Shigeaki; Tuyuzaki, Noriyoshi; Sudo, Yukio; Tanji, Mikio; Shimakawa, Yoshio. Japan Atomic

Energy Research Inst., Tokyo (Japan). Nov 1989. 100p. (In Japanese). Order Number DE90777719. Available from NTIS (US Sales Only), PC A05/MF A01.

This report presents the verification results of the HTTR (High Temperature engineering Test Reactor) plant dynamics analysis code 'ASURA', which is a code for analysis of HTTR plant control system. This report describes the analytical models and basic equations used in this code, evaluation of models, parameter survey, and cross check with other dynamics code, 'BLOOST-J2' and 'THYDE-HTGR', and analysis of Fort St. Vrain experiments for verification of the 'ASURA' code. Through the cross check with the available codes for analysis of plant dynamics and verification with those experiments, it was confirmed that the 'ASURA' code can be applicable for analysis of plant control system. (author).

28009 **Angular Fokker-Planck decomposition and representation techniques.** Landesman, M. (Louisiana State Univ., Baton Rouge, LA (USA). Nuclear Science Center); Morel, J.E. *Nuclear Science and Engineering (USA)*, 103(1): 1-11 (Sep 1989).

Two new methods for decomposing scattering cross sections into the forward-peaked and smooth components required for Boltzmann-Fokker-Planck calculations are presented. The first is slightly simpler than existing methods and offers the same level of effectiveness. The second is more expensive than existing methods, but is much more effective. Legendre moments that give a positive representation for the angular Fokker-Planck operator and can be used in standard S_n codes are presented. Computational results are given that demonstrate the effectiveness of these new decomposition and representation techniques.

28010 **Multifrequency binary sequence testing at the fast flux test facility.** Harris, R.A. (Westinghouse Hanford Co., Richland, WA (USA)); Chien, Y.M.; Clark, D.A.; Ritter, W.M.; Bennett, R.A.; Rothrock, R.B. Jr.; Sevenich, R.A. *Nuclear Science and Engineering (USA)*, 103(3): 294-301 (Nov 1989).

The multifrequency binary sequence experimental technique for measuring closed-loop frequency response functions has been implemented at the fast flux test facility for routine surveillance activities. The frequency content of the standard rod movement sequence has been shown to be sufficient to normalize the data at moderate frequencies. This obviates the need for auxiliary calibration measurements and provides the reactivity worth of the test control rod. Analyses of a series of tests conducted in 1986 illustrate that the rod worths inferred from the tests are consistent with zero-power measurements. Also, the dependence of the prompt feedback time constant on reactor conditions was determined.

2205 Environmental Aspects

Refer also to citation(s) 27757, 28048, 28076, 29042, 29043, 29101

28011 (DOE/RL–90-15) **National emissions standards for hazardous air pollutants application for approval of construction SP-100 Ground Engineering System Test Site.** USDOE Richland Operations Office, WA (USA). Apr 1990. 29p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. Order Number DE90007985. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The following Application for Approval of Construction is being submitted by the US Department of Energy — Richland Operations Office, for the SP-100 Ground Engineering System Test Site, which will provide a new source of radioactive emissions to the atmosphere. The US Department of Energy, the National Aeronautics and Space Administration, and the US Department of Defense have entered into an agreement to jointly develop space nuclear reactor power system. A ground test of a reactor is necessary to demonstrate technology readiness of this major subsystem before proceeding with the flight system development and demonstration. It is proposed that the SP-100 test reactor be tested in the existing decommissioned Plutonium Recycle Test Reactor containment building (309 Building). The reactor will be operated for at least three months and up to 2 yr. Following the test, the 309 Building will be decontaminated for potential use in other programs. It is projected that this new source of emissions will contribute approximately 0.05 mrem/yr dose to the maximally exposed offsite individual. This application is being submitted in response to those projected emissions that would provide the described offsite dose. 8 refs., 9 figs., 2 tabs.

28012 (DPST–88-927) **L-Lake/Steel Creek data base.** Dicks, A.S. Savannah River Lab., Aiken, SC (USA). Oct 1988. 122p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035;AC09-76SR00001. Order Number DE90009246. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This report documents the data collected from the L-Lake/Steel Creek Biological Monitoring Program from November 1985 through December 1988. The data base is comprised of information to evaluate the major biotic components of L Lake, Steel Creek, and portions of the Savannah River swamp. Data were collected in lake, stream, and wetlands areas that are potentially affected by the discharge of heated effluents from L-Reactor. Biological data consist of measurements of composition, abundance, distribution, and selected functional attributes of the algae, macrophyte, zooplankton, macroinvertebrate, and fish populations. Water chemistry data consist of measurements of concentration for numerous chemical parameters and other limnological parameters.

28013 (EGG-EAST–8663) **SCDAP/RELAP5 code extensions for modeling vapor source rates in Savannah River Site reactors.** Hagrman, D.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). Dec 1989. 51p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009645. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The design of a model intended to describe the release of fission products and structural materials that may form aerosols from UAl_x fuels is discussed. The model considers the release of noble gases, cesium and iodine from UAl_3 or UAl_4 grains within a solid aluminum fuel matrix by diffusion and blistering of the surface, release of zinc from a solid aluminum matrix by diffusion, evaporation of cadmium, and the release of xenon, krypton, iodine, cesium, zinc, and zinc iodide from liquid phases. The design is based on limited data that are surveyed. Also, the model is applied to a test case to demonstrate its abilities and limitations. 23 refs., 8 figs., 9 tabs.

28014 (EGG-NE–8896) **TRAPMELT/PULSE users' manual.** Hagrman, D.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). Feb 1990. 288p. Sponsored by U.S. DOE Nuclear Energy; Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. Order Number DE90009770. Available from NTIS, PC A13/MF A01; OSTI; INIS; GPO Dep.

This report is the users's manual for the TRAPMELT/PULSE computer code. The code is designed to calculate fission product transport and disposition when slug flow is a more appropriate approximation than a collection of well-mixed volumes connected by junctions. The name of the code was selected to acknowledge that the original version was based upon models used in the TRAPMELT 2.0 code. However, the coding was been completely redesigned for slug flow and for improved efficiency. Like TRAPMELT, the calculations assume five states. These states are vapor, aerosol, particles, condensed on surfaces, chemisorbed on surfaces, and aerosol particles deposited on surfaces. Mass transport of up to ten chemical species between the various states as an effluent slug proceeds down system piping is calculated. 29 refs.

28015 (NUREG/CR–4691-Vol.1) **MELCOR Accident Consequence Code System (MACCS): Volume 1, User's guide.** Chanin, D.I. (Technadyne Engineering Consultants, Inc., Albuquerque, NM (USA)); Sprung, J.L.; Ritchie, L.T.; Jow, Hong-Nian. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; Sandia National Labs., Albuquerque, NM (USA). Feb 1990. 260p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (SAND–86-1562-Vol.1). Available from NTIS, PC E10/MF E01 - GPO; OSTI; INIS.

This report contains 3 microfiche supplements.

This report describes the MACCS computer code. The purpose of this code is to simulate the impact of severe accidents at nuclear power plants on the surrounding environment. MACCS has been developed for the US Nuclear Regulatory Commission to replace the previous CRAC2 code, and it incorporates many improvements in modeling flexibility in comparison to CRAC2. The principal phenomena considered in MACCS are atmospheric

transport, mitigative actions based on dose projection, dose accumulation by a number of pathways including food and water ingestion, early and latent health effects, and economic costs. The MACCS code can be used for a variety of applications. These include (1) probabilistic risk assessment (PRA) of nuclear power plants and other nuclear facilities, (2) sensitivity studies to gain a better understanding of the parameters important to PRA, and (3) cost-benefit analysis. This report is composed of three volumes. This document, Volume 1, the Users's Guide, describes the input data requirements of the MACCS code and provides directions for its use as illustrated by three sample problems.

28016 (WHC-SP–0017-3) **Correlations for fission product release from N Reactor fuel under high-temperature accident conditions.** Birney, K.R.; Bechtold, D.B.; McCall, T.B. Westinghouse Hanford Co., Richland, WA (USA). Mar 1988. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90009487. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Empirical correlations were derived for fission product release from metallic uranium alloy 601 N Reactor fuel during postulated accident conditions in which the fuel nears, reaches, or exceeds the melting temperature. The correlations were based on a sparse data base from fuel melted in an inert or steam atmosphere. The empirical correlations are presented for use in subsequent deterministic analyses of N Reactor behavior during hypothetical severe accidents beyond the design basis. 20 refs., 4 figs., 4 tabs.

28017 (WHC-SP–0071) **Scoping analysis of fission product behavior and transport in the primary coolant system for postulated N Reactor severe accidents.** Cronenburg, A.W. Westinghouse Hanford Co., Richland, WA (USA). Feb 1988. 151p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90009489. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Scoping analyses are presented of fission product release, chemical form, transport, and deposition behavior for N Reactor loss-of- coolant accidents leading to significant fuel oxidation and melting. At fuel melt conditions 100% release of the noble gas (Xe and Kr) inventory is predicted. After complete oxidation of the metallic U fuel, significant release of other volatile fission products is predicted, ranging from 100% release of the I and Te inventories to about 30% Cs, 5% Ru, and 1% Sr. Once released from fuel, reactive volatile fission products will mix and chemically react with the steam/H_2 effluent, forming principally hydride and hydroxide species (e.g., CsOH, H_2Te, RuOH, SrOH) in addition to CsI. Such species are predicted to condense and chemisorb on the relatively cold outlet piping surfaces, so that essentially complete fission product retention is predicted in the primary coolant system for all but the noble gases. 25 refs., 19 figs., 39 tabs.

28018 (WHC-SP–0114) **An assessment of fission product chemical equilibrium for severe N Reactor accident conditions.** Bechtold, D.B. Westinghouse Hanford Co., Richland, WA (USA). Feb 1988. 63p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90009490. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

A calculation, by free-energy minimization, of fission product chemical forms was performed using SOLGASMIX-PV for a hypothetical loss-of-coolant accident (LOCA) with emergency core-cooling system failure at the Hanford N Reactor. A steam oxidant, acting on alloy 601 uranium fuel of 1000 MWd/ton exposure, released hydrogen, iodine, cesium, strontium, tellurium, ruthenium, carbon, and aluminum (the latter two are alloy constituents) in proportion to the extent of oxidation of uranium. Extents of steam consumption ranged from 1×10^{-6}% to 100%, corresponding to H_2/H_2O ratios of 1×10^{-8} to infinity. Proportionate, dilute gas-phase concentrations of fission elements were released as a result. Temperatures studied were from 500 to 1500 K and pressure was assumed to be one atmosphere. There were 77 chemical species of 9 elements studied in preliminary scoping calculations, and 41 were retained in detailed computations over the temperature and composition ranges. The results support a previous scoping study conclusion that most fission elements will plate out on the primary system piping before reaching N Reactor's confinement zone. 14 refs., 16 figs., 4 tabs.

28019 (WHC-SP–0407) **CONTAIN analysis of an N Reactor severe accident with hydrogen mitigation.** Claybrook, S.W. Westinghouse Hanford Co., Richland, WA (USA). Feb 1989. 189p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90009486. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

Calculations performed with the contain computer code to evaluate fission product release from N Reactor confinement are presented. Effects of confinement sprays and hydrogen mitigation system operation on fission product release are included in the evaluation. Comparisons between CONTAIN cases with and without sprays indicate operation of confinement sprays beyond about 30 hours will produce no benefit in reducing fission product release to the environment. Comparisons between CONTAIN cases with and without the hydrogen mitigation system show that mitigation system operation significantly increases fission product release while reducing the concentration of hydrogen within confinement. Favorable comparisons between CONTAIN and HECTR (a hydrogen mixing code used for N Reactor analyses) provide assurance that the CONTAIN model is implemented properly. 21 refs., 51 figs., 1 tab.

28020 (WSRC-RP–89-817) **Reactor operation environmental information document: Volume 3, Meteorology, surface hydrology, transport and impacts.** Bauer, L.R.; Hayes, D.W.; Hunter, C.H.; Marter, W.L.; Moyer, R.A. Westinghouse Savannah River Co., Aiken, SC (USA). Dec 1989. 283p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. Order Number DE90009279. Available from NTIS, PC A13/MF A01 - OSTI; GPO Dep.

This volume is a reactor operation environmental information document for the Savannah River Plant. Topics include meteorology, surface hydrology, transport, environmental impacts, and radiation effects. 48 figs., 56 tabs. (KD)

28021 **Radiometric analyses of floodplain sediments at the Savannah River Plant.** Lower, M.W. (E. I. du Pont de Nemours and Co., Aiken, SC (USA)). pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). DOE Contract AC09-76SR00001. (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

A Comprehensive Cooling Water Study to assess the effects of reactor cooling water discharges and related reactor area liquid releases to onsite streams and the nearby Savannah River has been completed at the US Department of Energy Savannah River Plant (SRP). Extensive radiometric analyses of man-made and naturally occurring gamma-emitting radionuclides were measured in floodplain sediment cores extracted from onsite surface streams at SRP and from the Savannah River. Gamma spectrometric analyses indicate that reactor operations contribute to floodplain radioactivity levels slightly higher than levels associated with global fallout. In locations historically unaffected by radioactive releases from SRP operations, ^{137}Cs concentrations were found at background and fallout levels of about 1 pCi/g. In onsite streams that provided a receptor for liquid radioactive releases from production reactor areas, volume-weighted ^{137}Cs concentrations ranged by core from background levels to 55 pCi/g. Savannah River sediments contained background and atmospheric fallout levels of ^{137}Cs only.

2206 Research, Test, and Experimental Reactors

Refer also to citation(s) 27974, 28001, 28002, 28005, 28008, 28010, 28044, 28060, 28070, 28087, 28088, 28729, 29101

28022 (CONF-900608–5) **Fuel cladding corrosion studies for the advanced neutron source.** Pawel, R.E.; Yoder, G.L.; Montgomery, B.H.; McFee, M.T. Oak Ridge National Lab., TN (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From American Nuclear Society annual meeting; Nashville, TN (USA); 10-15 Jun 1990. Order Number DE90005454. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Corrosion of aluminum alloy fuel cladding in ultra high flux research reactors such as the Advanced Neutron Source (ANS) may pose special temperature and structural problems associated with the buildup of reaction products during the lifetime of the core. Earlier research, mostly in support of the High Flux Research Reactor (HFIR) and the Advanced Test Reactor (ATR), has indicated that under extreme heat transfer conditions the exposure of aluminum and many aluminum alloys typically leads to the growth of an adherent oxidation product of significant thickness. In order to ensure that both the fuel and cladding integrity are maintained for the unique conditions imposed on the ANS fuel plates, an experimental facility was constructed so as to examine this type of corrosion behavior for a wide range of thermal-hydraulic conditions. This report briefly covers corrosion tests conducted on specimens of 6061 aluminum used as fuel cladding in the ANS.

28023 (DOE/ER/10725–T2) **University of Missouri Research Reactor (MURR) annual report, July 1988–June 1989: Annual report, July 1988–June 1989.** Missouri Univ., Columbia, MO (USA). Research Reactor Facility. 1989. 112p. Sponsored by U.S. DOE Energy Research. DOE Contract FG07-80ER10725. Order Number DE90009796. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

This annual report discusses the operation of the MURR reactor during the reporting period. A discussion of the research programs and/or resulting papers is also presented. (FI)

28024 (JAERI-M–89-136) **Annual report on operation, utilization and technical development of research reactors and hot laboratory: From April 1, 1988 to March 31, 1989.** Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 184p. (In Japanese). Order Number DE90777748. Available from NTIS (US Sales Only), PC A09/MF A01.

This report covers the activities of the Department of Research Reactor Operation in fiscal 1988. It also presents some technical topics on the reactor operation and utilization in details. The Department is responsible for operation of the research reactors, JRR-2 and JRR-4, and the Hot Laboratory. The research reactor JRR-3 is now under reconstruction to enhance the performance for utilization. In connection with the reactor operation, the various research and development activities in the area of fuel management, water chemistry, radiation monitoring and material irradiation have been made. In the Hot Laboratory, post-irradiation examinations of fuels and materials have been carried out along with the development of related techniques. (author).

28025 (JAERI-M–89-194) **Characteristic tests of medium-enriched uranium fuel core in JRR-2.** Tsunoda, Junsaku (Japan Atomic Energy Research Inst., Mutsu, Aomori (Japan). Mutsu Establishment); Koganezawa, Takashi; Banba, Masao; Shitomi, Hajimu; Nakano, Masahiro; Sato, Mitsugu; Kikuchi, Hiroyuki. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 23p. Order Number DE90777718. Available from NTIS (US Sales Only), PC A03/MF A01.

The Japan Research Reactor No.2 (JRR-2) is a heavy water moderated and cooled research reactor using 93% enriched uranium fuel formed in cylindrical and MTR fuel elements. Since attaining its initial criticality in October 1960, the JRR-2 has served with a maximum thermal neutron flux of 2×10^{14} n/cm^2·sec at the power level of 10 MW for various utilization, such as neutron physics and solid state physics. Since the first ascending to the nominal power of 10 MW in October 1962, The JRR-2 has been operated in stability and utilized for more than 28 years, and achieved approximately 66,000 hours operation. The reactor core has been converted from high-enriched uranium (HEU, 93% EU) fuel to medium-enriched uranium (MEU, 45% EU) fuel since November 1987, in order to increase proliferation resistance of nuclear materials in the JRR-2. In this paper the modification works and the characteristic tests on the JRR-2 are described. (author).

28026 (JAERI-M–89-198) **Evaluation of effective delayed neutron fraction and prompt neutron lifetime for High Temperature Engineering Test Reactor (HTTR).** Yamashita, Kiyonobu (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Shindo, Ryuichi; Murata, Isao; Nakata, Tetsuo. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 46p. (In Japanese). Order Number DE90777720. Available from NTIS (US Sales Only), PC A03/MF A01.

This report presents the evaluation method and results of the effective delayed neutron fraction β_{eff} and prompt neutron lifetime l for High Temperature Engineering Test Reactor. The values of β_{eff} and l were evaluated concerning the change with burnup and power level. The errors of values of β_{eff} and l were assessed. The value of β_{eff} changes from 0.0065 to 0.0047 in burnup period. The value of l changes from 0.67ms to 0.78ms. The evaluated errors of calculated value of β_{eff} and l were less than 10%. (author).

28027 (WHC-SA–0475) **Fracture toughness and tensile properties of alloy HT9 in thin sections under high neutron fluences.** Huang, F.H. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 40p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. (CONF-900623–2: 15. symposium on effects of radiation on materials, Nashville, TN (USA), 17-21 Jun 1990). Order Number DE90008386. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The effect of neutron radiation on the mechanical properties of alloy HT9 was evaluated by conducting postirradiation tensile and fracture toughness tests. Samples of HT9 were irradiated in the Experimental Breeder Reactor 2 (EBR-II) and Fast Flux Test Facility (FFTF) as part of material experiments. In addition, selected samples were obtained from a duct used in fuel pin tests in FFTF. The peak neutron fluence for these samples was 15.9×10^{22} n/cm^2 (E > 0.1 MeV), or about 80 dpa. Results of tests conducted at 205°C and at ambient temperature showed that the irradiation temperature had a larger influence on the mechanical behavior than neutron fluence. Irradiation at temperatures below 400°C produces a significant increase in the yield strength of HT9. At 360°C, an increase of more than 80% was found for tests conducted at ambient temperature. Tests on notched tensile specimens that had been irradiated at low temperature exhibited a linear elastic behavior with failure occurring with no yielding or elongation. 9 refs., 20 figs., 4 tabs.

28028 (WHC-SA–0683) **Fast Flux Test Facility core restraint system performance.** Hecht, S.L.; Trenchard, R.G. Westinghouse Hanford Co., Richland, WA (USA). Feb 1990. 8p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. (CONF-900613–1: International conference on fast reactor core and fuel structural behavior, Inverness (UK), 4-6 Jun 1990). Order Number DE90007023. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Characterizing Fast Flux Test Facility (FFTF) core restraint system performance has been ongoing since the first operating cycle. Characterization consists of prerun analysis for each core load, in-reactor and postirradiation measurements of subassembly withdrawal loads and deformations, and using measurement data to fine tune predictive models. Monitoring FFTF operations and performing trend analysis has made it possible to gain insight into core restraint system performance and head off refueling difficulties while maximizing component lifetimes. Additionally, valuable information for improved designs and operating methods has been obtained. Focus is on past operating experience, emphasizing performance improvements and avoidance of potential problems. 4 refs., 12 figs., 2 tabs.

28029 (WHC-SA–0741) **Dynamic effect of sodium-water reaction in fast flux test facility power addition sodium pipes.** Huang, S.N.; Anderson, M.J. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 10p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. (CONF-900617–4: Pressure vessels and piping conference: be in tune for the 90's, Nashville, TN (USA), 17-21 Jun 1990). Order Number DE90007819. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Fast Flux Facility (FFTF) is a demonstration and test facility of the sodium-cooled fast breeder reactor. A "power addition" to the facility is being considered to convert some of the dumped, unused heat into electricity generation. Components and piping systems to be added are sodium-water steam generators, sodium loop extensions from existing dump heat exchangers to sodium-water steam generators, and conventional water/steam loops. The sodium loops can be subjected to the dynamic loadings of pressure pulses that

are caused by postulated sodium leaks and subsequent sodium-water reaction in the steam generator. The existing FFTF secondary pipes and the new power addition sodium loops were evaluated for exposure to the dynamic effect of the sodium-water reaction. Elastic and simplified inelastic dynamic analyses were used in this feasibility study. The results indicate that both the maximum strain and strain range are within the allowable limits. Several cycles of the sodium-water reaction can be sustained by the sodium pipes that are supported by ordinary pipe supports and seismic restraints. Expensive axial pipe restraints to withstand the sodium-water reaction loads are not needed, because the pressure-pulse-induced alternating bending stresses act as secondary stresses and the pressure pulse dynamic effect is a deformation-controlled quantity and is self-limiting. 14 refs., 7 figs., 3 tabs.

2207 Plutonium and Isotope Production Reactors

Refer also to citation(s) 27743, 28012, 28013, 28016, 28017, 28018, 28019, 28020, 28049, 28050, 28052, 28076, 28077, 28078, 28079

28030 (EGG-EAST–8461) **RELAP5 calculations for tests to be conducted in the L-Reactor at the Savannah River Plant.** Shaw, R.A.; Bolander, M.A.; Davis, C.B. EG and G Idaho, Inc., Idaho Falls, ID (USA). Apr 1989. 323p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009760. Available from NTIS, PC A15/MF A01 - OSTI; GPO Dep.

A series of system tests are scheduled to be performed in the L-reactor during Spring, 1989. These tests will be used to provide data for benchmarking thermal-hydraulic computer codes and models. In support of these tests, RELAP5 pretest predictions were performed. The results of those calculations are included in this report. 4 refs., 5 figs., 1 tab.

28031 (JAERI-M–89-160) **The JMTR operation and technical development, 3: Fiscal 1986 - 1988.** Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1989. 277p. (In Japanese). Order Number DE90777716. Available from NTIS (US Sales Only), PC A13/MF A01.

The JMTR complex consists of a 50MW high neutron flux reactor (JMTR; Japan Materials Testing Reactor), the irradiation facilities, a hot laboratory and a nuclear critical assembly (JMTRC; Japan Materials Testing Reactor Critical Assembly). Many irradiation examinations have been carried out by the capsules, hydraulic rabbits and loop facilities in the JMTR since 1971 when 50MW high power operation was attained. These irradiation facilities and any post irradiation examination equipments have been fabricated, modified and replaced to meet the needs of the times. And now, one gas loop (OGL-1; Oarai Gas Loop-1), two water loops (OWL-2; Oarai Water Loop-2, OSF-1; Oarai Shround Facility-1), two hydraulic rabbits and any capsules are in the JMTR. This report describes the activities of the JMTR project performed in fiscal year 1986≈1988 as following; (1) the operations and maintenances of the JMTR complex, (2) fabrication of the operation backup systems of the reactor and irradiation facilities, (3) JMTR driver fuel enrichment reduce program, (4) the fabrications, modifications and replacements of the irradiation facilities and reactor core components, (5) any irradiation tests by the capsules, (6) developments of the irradiation techniques and post irradiation examination techniques, (7) the fundamental studies to conduct irradiation techniques, (8) future program in the JMTR. (author).

28032 (WSRC-RP–89-1270) **Monte Carlo analysis of the variation between axial power distribution and detector response.** Zino, J.F.; Losey, D.C. Westinghouse Savannah River Co., Aiken, SC (USA). [1989]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-900608–3: American Nuclear Society annual meeting, Nashville, TN (USA), 10-15 Jun 1990). Order Number DE90004656. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Short communication. REACTOR CORES/simulation; MONTE CARLO METHOD; POWER DISTRIBUTION; REACTOR MONITORING SYSTEMS; RESPONSE FUNCTIONS; SIMULATION; SAVANNAH RIVER PLANT; PRODUCTION REACTORS; NEUTRON TRANSPORT; PHOTON TRANSPORT

28033 (WSRC-RP–89-1380) **Production reactor characteristics.** Thiessen, C.W.; Hootman, H.E. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-900608–14: American Nuclear Society annual meeting, Nashville, TN (USA), 10-15 Jun 1990). Order Number DE90009253. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Reactors for the production of special nuclear materials share many similarities with commercial nuclear power plants. Each relies on nuclear fission, uses uranium fuel, and produces large quantities of thermal power. However, there are some important differences in production reactor characteristics that may best be discussed in terms of mission, role, and technology.

2208 Propulsion Reactors

28034 (BNL–44443) **Ultra high temperature particle bed reactor design.** Lazareth, O.; Ludewig, H.; Perkins, K.; Powell, J. Brookhaven National Lab., Upton, NY (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9004178–1: Vision-21 space travel for the next millenium, Cleveland, OH (USA), 3-4 Apr 1990). Order Number DE90009831. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This study is a computer analysis of a conceptual nuclear reactor. The purpose of this work is to design a direct nuclear propulsion engine which could be used for a mission to Mars. The main features of this reactor design are high values for I_{sp} and, secondly, very efficient cooling. This particle bed reactor consists of 37 cylindrical fuel elements embedded in a cylinder of beryllium which acts as a moderator and reflector. The fuel consists of a packed bed of spherical fissionable fuel particles. Gaseous H_2 passes over the fuel bed, removes the heat and is exhausted out of the rocket. The design was found to be neutronically critical and to have tolerable heating rates. Therefore, this Particle Bed Reactor Design is suitable as a propulsion unit for this mission.

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Refer also to citation(s) 27743, 27771, 27776, 27777, 27956, 27962, 27963, 27964, 27966, 27967, 27971, 27974, 27978, 27979, 27982, 27983, 27986, 27987, 28006, 28011, 28015, 28016, 28017, 28018, 28019, 28028, 28033, 28166, 28527, 29042, 29043, 29893

28035 (AD-A–217002/5/XAB) **Potential terrorist threat to commercial nuclear facilities.** Hoffman, B. Rand Corp., Santa Monica, CA (USA). Mar 1988. 14p. (RAND/P–7450). Available from NTIS, PC A03/MF A01.

In recent years, increased both in the total volume of terrorist incidents worldwide and the casualties resulting from such incidents have prompted renewed concern that terrorists might attack a nuclear facility. Among the reasons cited to explain the likelihood of such an attack is that as terrorism has become more frequent, public attention is not so readily claimed as it once was. Terrorists, therefore, have been forced to undertake more spectacular and, unfortunately, bloodier deeds. Accordingly, actions involving nuclear material or weapons may have become more attractive to some terrorist groups. In addition, state-sponsorship of terrorism, that is, support of terrorist organizations by foreign governments, has also increased significantly, providing terrorists with far greater capabilities than they have had in the past, while eliminating some of their constraints. As a result of these developments, in 1986 the Department of Energy (DOE) reviewed its adversary characterization and threat definition guidelines then in force and decided to place greater emphasis on guard weaponry, training, and tactical response exercises and to upgrade some physical security measures. The Nuclear Regulatory Commission (NRC) is now proposing to amend its physical protection and security personnel performance regulations to a level equivalent to the protection in place at comparable DOE fuel facilities.

28036 (BMU–1989-215) **Evaluation and analysis of documents with a view to safety-relevant problems, and**

consideration of these problems in the amendment of the Nuclear Engineering Code. 4. Technical report. Calculation of the rupture load of pipes and containers with longitudinal and circumferential defects. Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Herter, K.H. Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Stuttgart Univ. (Germany, F.R.). Staatliche Materialpruefungsanstalt. Dec 1987. 225p. (In German). Contract BMU SR 357. Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

The paper outlines the present status of the calculation of failure stress and behavior of pipes and containers with longitudinal and circumferential defects under internal pressure load and/or external bending momentum load. The experimental data of the research program of the Federal Ministry of Research and Technology on 'Phenomenological container bursting tests' phase 2 as well as data of tests carried out by Interatom were used for the comparison performed. The pipes used for these tests showed dimensions similar to those of the main coolant line of pressurized water reactors (PWR). The mathematical values were determined by the plastic critical load concepts as well as concepts of critical tension, since these calculation methods are, on the one hand, used for safety analyses and on the other hand included in the American set of rules as a criterion for the assessment of defects. (orig./DG).

28037 (BMU–1989-233) **Participation of the GRS in the 'Degraded piping program' of the USNRC.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Azodi, D.; Hoefler, A.; Sievers, J. Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Gesellschaft fuer Reaktorsicherheit mbH (GRS), Koeln (Germany, F.R.). Apr 1989. 200p. (In German). Contract BMU SR 271/3. (GRS-A–1557). Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

During the course of the Degraded Piping Program, Battelle was the organizer of three round-robin activities for advanced elasto-plastic fracture mechanics calculations (e.g. finite element method and J-estimation scheme). GRS participated in all of them and submitted finite element and J-estimation scheme results. As a main result of round-robin on elasto-plastic fracture mechanics calculations: Based on finite element calculations, the J-integral method (energy release rate) provided the ability to describe the fracture behaviour of flawed piping even in a very ductile material. (orig./HP).

28038 (BMU–1989-234) **Study on the load event aircraft crash on nuclear power plants. Phase 2.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Bauer, J.; Foros, P.; Schwarz, R. Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Industrieanlagen-Betriebsgesellschaft mbH, Ottobrunn (Germany, F.R.). Aug 1989. 275p. (In German). Contract BMU SR 292. (IABG-B-TF–1753). Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

This report covers the analysis of aircraft impact effects concerning plants of the DWR-Konvoi. The discussion of the DWR-model used and the presentation of the effects of varied aircraft data on the resulting time history of the impact force is followed by the presentation of the analysis of the local load-carrying-capacity of different designs of the secondary containment structure. The report is completed by the analysis of aircraft induced vibrations of the 'global' structure with respect to the effects of reduced wall thicknesses on shock initiation and - propagation within the plant. (orig./HP).

28039 (BMU–1989-237) **Safety analysis of pipelines during loads from external effects and during unforeseeable operating and incidental loads.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Bachmann, P.; Gruner, P.; Jonczyk, J.; Kuntze, W. Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Gesellschaft fuer Reaktorsicherheit mbH (GRS), Koeln (Germany, F.R.). Aug 1989. 203p. (In German). Contract BMU SR 271/3. (GRS-A–1602). Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

Earlier investigations concerning the performance of piping systems which are subject to seismic loads will be supplemented by sensitivity type of analyses. These refer to the uncertainties arising from the use of acceleration time histories which are computed on basis of a single floor response spectrum, to the influence of the coupling of vibration modes by damping, to energy dissipation due to non-linearities in hanger elements and to variations in support configurations. In addition, the topic of water hammers and steam hammer is addressed with special emphasis on questions concerning the reduction of the number of snubbers in a system. (orig.).

28040 (BMU–1989-239) **Study of the organizational structure of nuclear power plants and their coordination with supervisory organizations and structures. Pt. 1. Accident management in nuclear power plants.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Fraser Gesellschaft fuer Unternehmensberatung mbH, Essen (Germany, F.R.). Jul 1989. 168p. (In German). Contract BMU SR 410. Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

In the last few years the management of nuclear power plants as well as the supervising administration of the nuclear industry in Germany has focused more on emergency preparedness. The skills have been improved, but there are also improvements under way, yet. The study gives an overview about the status of emergency preparedness in German power plants, about the legal framework for emergency preparedness and about the elements of an effective emergency preparedness planning. However, it does not deal with technical accident management but with the organisational aspects of emergency planning. Also, the study gives a short outlook for future trends of development in the field of emergency preparedness in Germany. Major trends are the standardisation of organisational concepts, more training and more national and international feed back of know how on the topic. Yet, there is still some research work to be done, mainly to develop overall organisational standards and to profit from international experiences. (orig.).

28041 (BNL-NUREG–44323) **Assessment of thermal fatigue crack propagation in safety injection PWR lines.** Simos, N. (Brookhaven National Lab., Upton, NY (USA)); Reich, M.; Costantino, C.J.; Hartzman, M. Brookhaven National Lab., Upton, NY (USA). [1990]. 9p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (CONF-900617–5: Pressure vessels and piping conference: be in tune for the 90's, Nashville, TN (USA), 17-21 Jun 1990). Order Number DE90008820. Available from NTIS, PC A02/MF A01; OSTI; INIS.

Cyclic thermal stratification resulting in alternating thermal stresses in pipe cross sections has been identified as the primary cause of high cycle thermal fatigue failure. A number of piping lines in operating plants around the world, susceptible to thermal stratification, have experienced circumferential cracking as a result of high levels of alternating bending stresses. This paper addresses the mechanisms of crack initiation and crack growth and provides estimates of fatigue cycles to failure for a typical safety injection line with such cyclic load history. Utilizing a 3-D finite element analysis, the temperature profile and the corresponding thermal stress field of a complete thermal cycle in a safety injection line consisting of a horizontal pipe section and an elbow, is obtained. Since the observed cracking occurred in the region of the elbow-to-horizontal pipe weld, the analysis performed assessed (1) the impact of the level of local geometric discontinuities on the initiation of an inside surface flaw is greatest and (2) the number of thermal cycles required to drive a small surface crack through the pipe wall. 12 refs., 14 figs., 2 tabs.

28042 (CONF-900607–4) **Evaluation of digital fault-tolerant architectures for nuclear power plant control systems.** Battle, R.E. Oak Ridge National Lab., TN (USA). 28 Jan 1990. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From Advances in human factors research on man-computer interactions: nuclear and beyond; Nashville, TN

(USA); 10-15 Jun 1990. Order Number DE90007047. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Four fault tolerant architectures were evaluated for their potential reliability in service as control systems of nuclear power plants. The reliability analyses showed that human- and software-related common cause failures and single points of failure in the output modules are dominant contributors to system unreliability. The four architectures are triple-modular-redundant (TMR), both synchronous and asynchronous, and also dual synchronous and asynchronous. The evaluation includes a review of design features, an analysis of the importance of coverage, and reliability analyses of fault tolerant systems. An advantage of fault-tolerant controllers over those not fault tolerant, is that fault-tolerant controllers continue to function after the occurrence of most single hardware faults. However, most fault-tolerant controllers have single hardware components that will cause system failure, almost all controllers have single points of failure in software, and all are subject to common cause failures. Reliability analyses based on data from several industries that have fault-tolerant controllers were used to estimate the mean-time-between-failures of fault-tolerant controllers and to predict those failures modes that may be important in nuclear power plants. 7 refs., 4 tabs.

28043 (CONF-900608–12) **ORNL research in the robotics for advanced reactors program.** Sweeney, F.J. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. From American Nuclear Society annual meeting; Nashville, TN (USA); 10-15 Jun 1990. Order Number DE90008408. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In present day operating light water reactors (LWRs), it has been estimated that human radiation exposure costs approximately $5,000 per man-rem. With increasingly strict federal regulation of occupational radiation exposure, it is likely that this figure will be much higher in the future. One method current LWR operators have begun to utilize to reduce occupational exposures is the use of robots. These robots usually have very limited capabilities, require a trained operator, and are designed to perform only one specific task. These limited capabilities, "one off" construction, and need for a skilled operator prevents widescale economic application of robots in the current generation of LWRs to the performance of even simple everyday tasks. Because many advanced reactors such as the Power Reactor Inherently Safe Module (PRISM), the Integral Fast Reactor (IFR), and the Modular High Temperature Gas Reactor (MHTGR) are now in the conceptual design phases, the Department of Energy (DOE) and reactor manufacturers recognized the need to incorporate extensive use of robotics in the performance of routine tasks. DOE therefore provides support to four universities (the Universities of Florida, Michigan, Tennessee, and Texas) and Oak Ridge National Laboratory (ORNL) to pursue research leading to the development and deployment of advanced robotic systems capable of performing tasks that are hazardous to humans, that generate significant occupational radiation exposure, and whose execution times can be reduced if performed by an automated system. The goal of this program, the Robotics for Advanced Reactors program, is to develop a generation of advanced robotic systems capable of economically performing surveillance, maintenance, and repair tasks in nuclear facilities and other hazardous environments. 4 refs., 2 figs.

28044 (CONF-900617–2) **Analytical simulation of seismic testing of VKL (Versuchskreislauf) piping system at the HDR (Heissdampfreaktor) Test Facility.** Srinivasan, M.G.; Kot, C.A.; Hsieh, B.J. Argonne National Lab., IL (USA). [1990]. 26p. Sponsored by Nuclear Regulatory Commission. DOE Contract W-31109-ENG-38. From Pressure vessels and piping conference: be in tune for the 90's; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE90005660. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Dynamic tests with simulated earthquake excitation (SHAM) were performed during April–May 1988 on the VKL (Versuchskreislauf) piping system at the HDR (Heissdampfreaktor) Test Facility in Kahl/Main, Federal Republic of Germany. The major objectives of these test were to study the behavior of a full-scale in-plant piping system subjected to a range of seismic excitation levels, from design levels to those that exceed design levels manifold and those that might induce failure of pipe supports or plasticity in the pipe runs, and to establish seismic margins for piping and pipe supports. Data obtained in the tests are also being used to validate analytical method for piping response calculation. Detailed reports on the SHAM experiments are given elsewhere. The paper describes an effort to evaluate the subsystem analysis module of the SMACS code using some of the SHAM test data. The SMACS modules a linear finite-element program, derived from the SAP4 code and capable of calculating the response of nuclear power plant subsystems subjected to multiple, independent acceleration excitation. The evaluation is based on a comparison of computational results of simulation of SHAM test with corresponding test measurements. 4 refs., 7 figs., 2 tabs.

28045 (CONF-900617–8) **Inclusion of unstable ductile tearing and extrapolated crack-arrest toughness data in PWR vessel integrity assessment.** Dickson, T.L.; Cheverton, R.D.; Shum, D.K. Oak Ridge National Lab., TN (USA). [1990]. 10p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. Contract 1886-8011-9B. From Pressure vessels and piping conference: be in tune for the 90's; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE90009427. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Over the past several years, the Heavy-Section Steel Technology Program at Oak Ridge National Laboratory has performed a series of large-scale fracture-mechanics experiments. These experiments have demonstrated that prototypical nuclear reactor vessel steels can exhibit crack-arrest toughness values considerably above 220 MPa·$\sqrt{m}$, although arrest can be followed immediately by unstable ductile tearing. This report evaluates the influence of the crack-arrest toughness above 220 MPa·$\sqrt{m}$ on the integrity assessments of nuclear reactor pressure vessels for pressurized-thermal shock (PTS) loading conditions, taking into account the potential for unstable ductile tearing following arrest. The influence of the high crack-arrest toughness data and unstable ductile tearing on pressurized-water reactor vessel integrity assessment is PTS transient dependent. However, it appears that the potential benefit from crack-arrest events corresponding to toughness values above 240 MPa·$\sqrt{m}$ for low-upper-shelf weld (LUSW) material and above 370 MPa·$\sqrt{m}$ for those vessels not containing LUSW material will usually be negated by unstable ductile tearing. 27 refs., 15 figs.

28046 (DOE/ID–10258) **Benchmarks of severe fuel damage tests using a stand-alone version of heatup from MAAP-DOE, Task 3.6.8.** Sharon, A.; Burelbach, J.P.; Baumgarten, I.; Tashjian, V.S.; Hammersley, R.J. Fauske and Associates, Inc., Burr Ridge, IL (USA). Mar 1990. 200p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (MISC–89133). Order Number DE90009633. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

The results of three benchmark efforts are presented which assess the adequacy of the core HEATUP model that was developed for MAAP by the DOE in predicting the thermal-hydraulic response of a simulated LWR core under conditions leading to severe fuel damage. The model is applied to experiments performed at Idaho National Engineering Laboratory (PBF-SFD 1-1), Pacific Northwest Laboratory (FLHT-2), and Kernforschungszentrum Karlsruhe (CORA-12). Key quantities of interest in this study are the hydrogen generation rate, the bundle temperature distribution, and material relocation. Consistent good agreement is demonstrated between the model predictions and experimental data. 11 refs., 109 figs., 12 tabs.

28047 (DOE/RL–90-14) **Prevention of significant deterioration application for approval to construct SP-100 Ground Engineering System Test Site.** USDOE Richland Operations Office, WA (USA). Apr 1990. 73p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. Order Number DE90007986. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The following application is being submitted by the US Department of Energy, Richland Operations Office, P.O. Box 550, Richland, Washington 99352, pursuant to WAC 173-403-080, and

in compliance with the Department of Ecology "Guide to Processing a Prevention of Significant Deterioration (PSD) Permit" for a new source of airborne radionuclide emissions at the Hanford Site in Washington State. The new source, the SP-100 Ground Engineering System (GES) Test Site, will be located in the 309 Building of the 300 Area. The US Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), and the US Department of Defense (DOD) have entered into an agreement to jointly develop space nuclear reactor power system technology. The DOE has primary responsibility for developing and ground testing the nuclear subsystem. A ground test of a reactor is necessary to demonstrate technology readiness of this major subsystem before proceeding with the flight system development and demonstration. The SP-100 GES Test Site will provide a location for the operation and testing of a prototype space-based, liquid metal-cooled, fast flux nuclear reactor in an environment closely simulating the vacuum and temperature conditions of space operations. The purpose of the GES is to develop safe, compact, light-weight and durable space reactor power system technology. This technology will be used to provide electric power, in the range of tens to hundreds of kilowatts, for a variety of potential future civilian and military space missions requiring long-term, high-power level sources of energy. 20 refs., 8 figs., 7 tabs.

28048 (DOE/RL–90-16) **Department of Health application for approval of construction SP-100 Ground Engineering System Test Site.** USDOE Richland Operations Office, WA (USA). Apr 1990. 68p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE90007984. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The following Application For Approval of Construction is being submitted by the US Department of Energy-Richland Operations Office, for the SP-100 Ground Engineering System Test Site, which will provide a new source of radioactive emissions to the atmosphere. The US Department of Energy, the National Aeronautics and Space Administration, and the US Department of Defense have entered into an agreement to jointly develop space nuclear reactor power system technology. A ground test of a reactor is necessary to demonstrate technology readiness of this major subsystem before proceeding with the flight system development and demonstration. It is proposed that the SP-100 test reactor be tested in the existing decommissioned Plutonium Recycle Test Reactor containment building (309 Building). The reactor will be operated for at least three months and up to 2 yr. Following the test, the 309 Building will be decontaminated for potential use in other programs. It is projected this new source of emissions will contribute approximately 0.05 mrem/yr dose to the maximally exposed offsite individual. This application is being submitted in response to those projected emissions that would provide the described offsite dose. 28 refs., 9 figs., 7 tabs.

28049 (EGG-EAST–8336) **Benchmarking the RELAP5 L-Reactor model with Savannah River reactor test data.** Davis, C.B.; Fletcher, C.D.; Rodriguez, S.B. EG and G Idaho, Inc., Idaho Falls, ID (USA). Apr 1989. 80p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009789. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

A quality-assured RELAP5 input model of the L-Reactor at the Savannah River Plant (SRP) was developed to support the analysis of a loss-of-coolant accident (LOCA). The RELAP5/MOD2.5 computer code and the L-Reactor model were benchmarked against SRP data to demonstrate their applicability for thermal-hydraulic analysis of SRP reactors. The code and model were benchmarked against data from several different reactor system tests including the 1985 AC Process Flow Tests, the 1983 Cavitation Tests, the 1987 AC Pump Trip Tests, and the 1970 Starved Pump Tests. Results of the benchmark calculations were favorable, yielding confidence in the capability of RELAP5 and the L-Reactor model to determine system response during normal and transient operation, including a LOCA. 17 refs., 30 figs., 11 tabs.

28050 (EGG-EAST–8385) **Emergency response guide-B ECCS guideline evaluation analyses for N reactor.** Chapman, J.C.; Callow, R.A. EG and G Idaho, Inc., Idaho Falls, ID (USA). Jul 1989. 87p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009791. Available from NTIS, PC E06/MF E01; OSTI; INIS; GPO Dep.

Includes 2 microfiche supplements.

INEL conducted two ECCS analyses for Westinghouse Hanford. Both analyses will assist in the evaluation of proposed changes to the N Reactor Emergency Response Guide-B (ERG-B) Emergency Core System (ECCS) guideline. The analyses were a sensitivity study for reduced-ECCS flow rates and a mechanistically determined confinement steam source for a delayed-ECCS LOCA sequence. The reduced-ECCS sensitivity study established the maximum allowable reduction in ECCS flow as a function of time after core refill for a large break loss-of-coolant accident (LOCA) sequence in the N Reactor. The maximum allowable ECCS flow reduction is defined as the maximum flow reduction for which ECCS continues to provide adequate core cooling. The delayed-ECCS analysis established the liquid and steam break flows and enthalpies during the reflood of a hot core following a delayed ECCS injection LOCA sequence. A simulation of a large, hot leg manifold break with a seven-minute ECCS injection delay was used as a representative LOCA sequence. Both analyses were perform using the RELAP5/MOD2.5 transient computer code. 13 refs., 17 figs., 3 tabs.

28051 (EGG-EAST–8426) **Horizontal flow stratification modifications for RELAP5/MOD3.** Riemke, R.A. EG and G Idaho, Inc., Idaho Falls, ID (USA). Feb 1989. 42p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. Order Number DE90009793. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The report documents the modifications to the horizontal stratification model in RELAP5/MOD3. Background information, model description and solution method, coding changes, and assessment of these changes are described in the report. The use of the phasic velocity difference in the Taitel-Dukler criterion along with a mass flux criterion improved the void fraction data comparison for the TPTF tests. Modifications and error corrections to the void gradient term improved the code's capability to calculate the correct velocities. 15 refs., 23 figs., 1 tab.

28052 (EGG-EAST–8449) **Description of the two-loop RELAP5 model of the L-Reactor at the Savannah River Site.** Cozzuol, J.M.; Davis, C.B. EG and G Idaho, Inc., Idaho Falls, ID (USA). Dec 1989. 65p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009788. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

A two-loop RELAP5 input model of the L-Reactor at the Savannah River Site (SRS) was developed to support thermal-hydraulic analysis of SRS reactors. The model was developed to economically evaluate potential design changes. The primary simplifications in the model were in the number of loops and the detail in the moderator tank. The six loops in the reactor were modeled with two loops, one representing a single loop and the other representing five combined loops. The model has undergone a quality assurance review. This report describes the two-loop model, its limitations, and quality assurance. 29 refs., 18 figs., 10 tabs.

28053 (EGG-M–89005) **Plans and status of RELAP5/MOD3.** Weaver, W.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 5p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (CONF-890173–6: 1. international RELAP-5 users seminar, College Station, TX (USA), 31 Jan - 2 feb 1989). Order Number DE90009610. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

RELAP5/MOD3 is a pressurized water reactor (PWR) system analysis code being developed jointly by the US Nuclear Regulatory Commission (USNRC) and consisting of several of the countries that are members of the International Code Assessment and Applications Program (ICAP). This code development program is called the ICAP Code Improvement Program. The mission of the RELAP5/MOD3 code improvement program is to develop a code version suitable for the analysis of all transients and postulated accidents in PER systems including both large and small break loss of coolant accidents (LOCA's) as well as the full range of operational transients. The emphasis of the RELAP5/MOD3 development will be on large break LOCA since previous versions of RELAP5 were developed for and assessed against small break LOCA and

operation transient test data. The paper discusses the various code models to be improved and presents the results of work completed to date.

28054 (EGG-M–89359) **On dual Lagrangian hyperbolic models for one dimensional two phase flow problems.** Shieh, A.S.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 16p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-9006107–2: Symposium on numerical methods for multi-phase flows, Toronto (Canada), 3-9 Jun 1990). Order Number DE90007012. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A dual Lagrangian computational hyperbolic model for two-phase flow is presented. The implicit Richtmeyer-von Neumann method is used to solve the resulting difference equations. The method is unconditionally stable and solves the shock tube with no mass diffusion. 14 refs., 2 figs.

28055 (EGG-SSRE–8875) **Generic component failure data base for light water and liquid sodium reactor PRAs [probabilistic risk assessments].** Eide, S.A.; Chmielewski, S.V.; Swantz, T.D. EG and G Idaho, Inc., Idaho Falls, ID (USA). Feb 1990. 72p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009642. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

A comprehensive generic component failure data base has been developed for light water and liquid sodium reactor probabilistic risk assessments (PRAs). The Nuclear Computerized Library for Assessing Reactor Reliability (NUCLARR) and the Centralized Reliability Data Organization (CREDO) data bases were used to generate component failure rates. Using this approach, most of the failure rates are based on actual plant data rather than existing estimates. 21 refs., 9 tabs.

28056 (EPRI-NP–6778) **Reduction of critical path time for BWR recirculation system decontaminations: Final report.** Beaman, T.A. (Niagara Technical Consultants, Niagara Falls, NY (USA)); Smee, J.L. Electric Power Research Inst., Palo Alto, CA (USA); Niagara Technical Consultants, Niagara Falls, NY (USA). c Mar 1990. 49p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The successful use of dilute chemical decontamination technology on a large number of reactor water recirculation (RWR) systems in US BWRs has enabled the various utilities involved to avoid a significant amount of occupational radiation exposure (ORE). Although a lot of progress has already been made in reducing the critical path time required to perform such applications, there are additional ways in which it can be reduced. This report identifies a number of these. Four major decontamination tasks, each of which is normally performed on the critical path of the outage, are examined as they occur chronologically during a typical application. For these, specific recommendations ranging from minor alterations to current procedures all the way up to fundamental adjustments in the way in which the actual work is performed, are presented. The potential time savings are then summarized based upon three hypothetical levels of effort, minimum, medium and maximum, that a particular utility may be willing to invest. 3 refs., 6 figs., 5 tabs.

28057 (GRS-F–174) **Surveys of research projects concerning nuclear facility safety, financed by the Federal Ministry for the Environment, Nature Protection and Reactor Safety, 1988. 13. annual report on SR-projects.** Gesellschaft fuer Reaktorsicherheit mbH (GRS), Koeln (Germany, F.R.). Nov 1989. 195p. (In German). Order Number DE90780230. Available from NTIS (US Sales Only), PC A09/MF A01.

Each progress report is a collection of individual reports, categorized by subject matter. They are a documentation of the contractor's progress, rendered by themselves on standardized forms, published, for the sake of general information on progress made in investigations concerning reactor safety, by the project attendance department of the GRS. The individual reports have serial numbers. Each report includes particulars of the objective, work carried out, results obtained and plans for project continuation. (orig.).

28058 (JAERI-M–89-179) **Analytical study for PHEBUS experiment 215R by FRAP-T4 calculation code.** Hashimoto, Kazuichiro (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 22p. Order Number DE90777736. Available from NTIS (US Sales Only), PC A03/MF A01.

The PHEBUS program at the Cadarache Nuclear Research Center in France was performed to investigate fuel behavior under conditions of a loss-of-coolant accident (LOCA) of a PWR. The program consisted of four phases. Phase I included three experiments with the single rod and sixteen experiments with the 25-rod bundle. Purpose of the Phase I experiments was to clarify thermal-hydraulic condition of the PHEBUS loop. Phase II experiments were performed with the 25-rod bundle to obtain data on fuel behavior during a large break LOCA. Phases III and IV were devoted to severe fuel damage research. A sensitivity study using the data of the experiment 215R has been made with the calculation code FRAP-T4. A gap size between the fuel pellet and the cladding, and thickness of the cladding were considered as the parameters in this study to investigate how they affect to fuel behavior during a LOCA condition. (author).

28059 (JAERI-M–89-208) **Conceptual design of SPWR, a PWR with enhanced passive safety.** Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 332p. (In Japanese). Order Number DE90777753. Available from NTIS (US Sales Only), PC A15/MF A01.

A conceptual design has been carried out on a new type of integrated pressurized water reactor, SPWR (System-integrated PWR). This reactor installs a poison tank (borated water filled) in the reactor vessel instead of control rod drive system. Three hydraulic pressure valves are installed as the upper interface between the poison tank and primary coolant. A 700MWe power plant with twin 1100MWt SPWRs which are installed in a reactor building has been studied. Design and analysis have been made on the reactor core, reactor (reactor vessel, steam generator, main circulating pump, pressurizer, poison tank and their integration), plant systems (main and sub systems), layout, construction scheme, operation and maintenance, safety related components, reactor dynamics, economics and R and D needs. Passive safety features are also studied. (author).

28060 (K/CSD/INF–89/40) **Thermal hydraulic system simulation of the HFIR with RELAP5/MOD2.** Wendel, M.W.; Morris, D.G. Oak Ridge Gaseous Diffusion Plant, TN (USA). [1989]. 5p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. (CONF-900608–1: American Nuclear Society annual meeting, Nashville, TN (USA), 10-15 Jun 1990). Order Number DE90004148. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A model of the High Flux Isotope Reactor (HFIR) in Oak Ridge has been developed to simulate loss-of-coolant accidents (LOCAs) and operational transients using the RELAP5/MOD2 program. This work constitutes a portion of the analytical studies being performed to update the HFIR Thermal-Hydraulic Safety Analysis. RELAP5 permits the determination of the survivability of the core through various transients based on the critical heat flux (CHF) criteria rather than the more conservative incipient boiling criteria, which have been used previously. Preliminary simulations for small-diameter breaks have been completed, and results are discussed in this document. 4 refs., 1 fig.

28061 (KFK–4645) **Analysis of SIMMER calculations for SNR-300 performed at the University of Bremen.** Maschek, W.; Heger, R. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Schneller Brueter. Jan 1990. 98p. (In German). Order Number DE90773723. Available from NTIS (US Sales Only), PC A05/MF A01.

The report No. 8 of July 1984 (author R. Donderer) displays SIMMER-II calculations which partly results in energy releases for a hypothetical Bethe-Tait accident beyond the design limit of SNR-300. Due to the wish of the licensing authorities this report was to be introduced into a general assessment of recent scientific results.

In internal KfK report the two calculations with the highest energy releases, cases A6 and B3, were analyzed in detail. The mechanical energy releases of case A6 were 806 MJ and for B3, 435 MJ respectively thus going beyond the design limit of 370 MJ. The analyses show that the high energy releases have no meaningful physical background. They result from numerical instabilities caused by neglecting obvious facts like orifices in the subassemblies or blockage formation so that deficiencies in the SIMMER-code concerning the pressure calculation at flow cross section changes have a drastic impact. Donderer has performed various interferences with the SIMMER program which are inconsistent and even erroneous. Own calculations demonstrated that by taking into account the specific design features and physical phenomena properly, these deficiencies in SIMMER have no impact and energy releases are calculated which are consistent with earlier studies and range much below the design limit of SNR-300. In a further KfK internal report (Feb. 1987) additional analyses concerning Donderer's SIMMER calculations were documented. The numerical deficiencies in the hydrostatic pressure calculation at flow cross section changes had been finally eliminated in SIMMER and also the flow behaviour at flow cross section changes had been improved. A recalculation of the Bremen case with the highest energy release (case A6) showed that after improving the numerics of the code and stabilizing the calculation the mechanical work potential dropped from originally 800 MJ by an order of magnitude to 80 MJ. (orig./HP).

28062 (LA–10639-MS) **An investigation of steam-explosion loadings with SIMMER-2.** Bohl, W.R. Los Alamos National Lab., NM (USA). Mar 1990. 488p. Sponsored by Nuclear Regulatory Commission. DOE Contract W-7405-ENG-36. Order Number DE90009219. Available from NTIS, PC A21/MF A01; OSTI; INIS; GPO Dep.

The purpose of this work was to provide a reasonable estimate of the maximum loads that might be expected at the upper head of a pressurized water reactor following an in-vessel steam explosion. These loads were determined by parametric cases using a specially modified and calibrated version of the SIMMER-II computer code. Using the determined range of loads, the alpha-mode containment failure probability was to be estimated using engineering judgment. In this context, an alpha-mode failure is defined as resulting from a missile, produced by a steam explosion, and assuming core melt has occurred. 51 refs., 185 figs., 19 tabs.

28063 (ND-R–1173(S)(pt.1)) **The MERLIN programme: Pt. 1: An overview.** Worswick, D. (UKAEA Northern Research Labs., Springfields (UK)); Hindle, E.D.; Stacey, R.D.; Stevens, M.; Wickett, A.J.; GArlick, A. UKAEA Northern Research Labs., Springfields (UK). Aug 1989. 78p. Order Number DE90624993. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

The MERLIN rig at the Northern Research Laboratories, Springfields, was intended to investigate the deformation behaviour of Zircaloy fuel rod cladding under conditions approximating those of a large break Loss of Coolant Accident (LOCA). In this rig, an assembly of electrically heated fuel rod simulators (6x6 cluster) was subjected to a temperature transient simulating that predicted to occur in a LOCA, including the initiation of bottom reflooding at a suitable stage. The main aim of the MERLIN programme was to investigate the extent of sub-channel blockage produced during clad deformation under conditions of high mechanical restraint, in two phase cooling conditions. The programme was to consist of four test bundles, the final two of which would be used for ballooning experiments in which high sub-channel blockage would be produced by a suitable choice of test conditions. A major part of the programme was to provide validation data for reactor accident codes used in the CEGB clad ballooning safety case for Sizewell B. This report, one of a series which describes the programme in detail, is an overview of the MERLIN programme. It provides background, summarises those reports which discuss the programme in detail and draws attention to those areas where useful information has been obtained. (author).

28064 (ND-R–1173(S)(pt.5)) **The MERLIN programme: Pt. 5: Bundle B thermal hydraulic test series.** Worswick, D. (UKAEA Northern Research Labs., Springfields (UK)); Walker, J.C. UKAEA Northern Research Labs., Risley (UK). Aug 1989. 130p. Order Number DE90624994. Available from NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS.

The MERLIN rig is intended to investigate the deformation behaviour of Zircaloy fuel rod cladding under conditions approximating those of a large break loss of coolant accident (LOCA). An assembly of electrically heated fuel rod simulators (6X6 cluster) is subjected to a temperature transient simulating that predicted to occur in a LOCA, including the initiation of bottom reflooding at a suitable stage. The Bundle B Thermal-Hydraulic test series was intended to commission the test facility and to obtain the operating conditions which would produce a suitable temperature transient for the investigation of clad ballooning at high coolant sub-channel blockages. In addition, the vibration produced by reflooding was to be measured during the course of the programme. The early stages of the programme (ramp test and low power reflooding tests) were successfully accomplished, although a major part of the test section instrumentation was found to be unreliable. A limited number of low power tests designed to investigate starting conditions was followed by an accelerated programme to derive a high temperature burst test transient, with the limited aim of allowing good rig commissioning data to be obtained. A successful burst test was carried out as the final experiment of the programme. (author).

28065 (ND-R–1173(S)(pt.7)) **The MERLIN programme: Pt. 7: Vibration measurement tests.** Worswick, D.; Melvin, G.T.; Walker, J.C. UKAEA Northern Research Labs., Springfields (UK). Aug 1989. 68p. Order Number DE90624995. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This report describes a series of experiments carried out in the MERLIN rig to provide information about the vibration response of a fuel rod during the reflood stage of a large break Loss of Coolant Accident (LOCA) in a PWR. Vibration of fuel rods in a LOCA is expected to influence the stability and radial position of the fuel stack within the cladding, and these factors are known to have a considerable influence on cladding deformation behaviour. The MERLIN rig at SL is intended to investigate the deformation behaviour of Zircaloy fuel rod cladding under conditions approximating those of a large break LOCA. An assembly of electrically heated fuel rod simulators (6X6 cluster) is subjected to a temperature transient simulating that predicted to occur in a LOCA, including the initiation of bottom reflooding at a suitable stage. As part of the preliminary test programme to characterise the rig, vibration measurements were made during a series of experiments in which a flat top transient (steady state condition) was achieved during reflood cooling. It was found that the vibration response was not sensitive to cladding temperature (500 - 650^{0}C), but was dependent on the time into reflood for early stages of the transient. (author).

28066 (NUREG–1266-Vol.4) **NRC safety research in support of regulation–FY 1989: Volume 4.** Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Apr 1990. 47p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

This report, the fifth in a series of annual reports, was prepared in response to congressional inquiries concerning how nuclear regulatory research is used. It summarizes the accomplishments of the Office of Nuclear Regulatory Research during FY 1989. The goal of this office is to ensure that safety-related research provides the technical bases for rulemaking and for related decisions in support of NRC licensing and inspection activities. This research is necessary to make certain that the regulations that are imposed on licensees provide an adequate margin of safety so as to protect the health and safety of the public. This report describes both the direct contributions to scientific and technical knowledge with regard to nuclear safety and their regulatory applications.

28067 (NUREG–1333-FINAL) **Maintenance approaches and practices in selected foreign nuclear power programs and other US industries: Review and lessons learned: Final report.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Regulatory Applications. Apr 1990. 104p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A06/MF A01 - GPO; OSTI; INIS.

The Commission published a Notice of Proposed Rule-making on Maintenance of Nuclear Power Plants on November 28, 1988, spelling out NRC's expectations in maintenance. In preparing the

proposed rule, the NRC reviewed maintenance practices in other countries and considered maintenance approaches in other industries in this country. As a result of the review of maintenance practices, it was concluded that certain practices in the following areas have been found to contribute significantly to effective maintenance: (1) systems approach; (2) effectiveness monitoring; (3) technician qualifications and motivation; and (4) maintenance organization. 87 refs., 26 figs., 2 tabs.

28068 (NUREG/CR–4882) **Qualification process for ultrasonic testing in nuclear inservice inspection applications.** Spanner, J.C. (Pacific Northwest Lab., Richland, WA (USA)); Doctor, S.R.; Taylor, T.T.; Muscara, J. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 145p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC06-76RL01830. (PNL–6179). Available from NTIS, PC A07/MF A01 - GPO; OSTI; INIS.

This report documents a project whose objective was to develop recommended requirements and processes for qualifying ultrasonic testing/inservice inspection (UT/ISI) systems for ISI of nuclear power plant components. An overall qualification process intended to achieve statistically designed performance validations including prerequisite training and other qualification recommendations is described. This report also contains recommendations for the test specimens, environment, and other conditions under which the qualification processes should be conducted. Active involvement in the ASME Section 11 Subgroup on Nondestructive Examination (SGNDE) and an Ad Hoc Task Group authorized by the SGNDE became an integral part of this task after a PNL draft document was presented in November 1984. The major areas where specific enhancements to Section 11 were recommended in this document included more stringent criteria for Level 3 qualifications, explicit recommendations for requalification, inauguration of periodic (annual) training, and recommendations for coordinating and administering the entirely new qualification process on a national (rather than local employer) basis. 23 refs., 14 figs., 2 tabs.

28069 (NUREG/CR–5438) **Basic considerations in predicting error probabilities in human task performance.** Fleishman, E.A. (George Mason Univ., Fairfax, VA (USA). Center for Behavioral and Cognitive Studies); Buffardi, L.C.; Allen, J.A.; Gaskins, R.C. III. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research; George Mason Univ., Fairfax, VA (USA). Center for Behavioral and Cognitive Studies. Apr 1990. 41p. Sponsored by Nuclear Regulatory Commission. (CBCS–90-1). Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

It is well established that human error plays a major role in the malfunctioning of complex systems. This report takes a broad look at the study of human error and addresses the conceptual, methodological, and measurement issues involved in defining and describing errors in complex systems. In addition, a review of existing sources of human reliability data and approaches to human performance data base development is presented. Alternative task taxonomies, which are promising for establishing the comparability on nuclear and non-nuclear tasks, are also identified. Based on such taxonomic schemes, various data base prototypes for generalizing human error rates across settings are proposed. 60 refs., 3 figs., 7 tabs.

28070 (NUREG/IA–0021) **RELAP5/MOD2 calculations of OECD LOFT test LP-SB-2.** Hall, P.C. (Central Electricity Generating Board, Barnwood (UK). Generation Development and Construction Div.). Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Central Electricity Generating Board, Barnwood (UK). Generation Development and Construction Div. Apr 1990. 40p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

To help in assessing the capabilities of RELAP5/MOD2 for PWR Fault Analysis, the code is being used by CEGB to simulate several small LOCA and pressurized transient experiments in the LOFT experimental reactor. The present report describes an analysis of small LOCA test LP-SB-02, which simulated a 1% hot leg break LOCA in a PWR, with delayed tripping of the primary coolant pumps. This test was carried out under the OECD LOFT Programme. An important deficiency identified in the code is inadequate modelling of the quality of the fluid discharged from the hot leg into the break pipework. This gives rise to large errors in the calculated system mass inventory. The effect of using an improved model for vapor pull-through into the break is described. A second significant code deficiency identified is the failure to predict the occurrence of stratified flow in the hot leg at the correct time in the test. It is believed that this error contributed to gross errors in the loop flow conditions after about 1300s. Additional separate effects data necessary to resolve the code deficiencies encountered are identified.

28071 (NUREG/IA–0030) **Assessment of RELAP5/MOD2 code using loss of offsite power transient data of KNU [Korea Nuclear Unit] No. 1 Plant.** Chung, Bud-Dong (Korea Advanced Energy Research Inst., Daeduk-Danji (Republic of Korea). Korea Nuclear Safety Center); Kim, Hho-Jung; Lee, Young-Jin. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Korea Advanced Energy Research Inst., Daeduk-Danji (Republic of Korea). Korea Nuclear Safety Center; Seoul National Univ. (Republic of Korea). Apr 1990. 98p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

This report presents a code assessment study based on a real plant transient that occurred on June 9, 1981 at the KNU #1 (Korea Nuclear Unit Number 1). KNU #1 is a two-loop Westinghouse PWR plant of 587 Mwe. The loss of offsite power transient occurred at the 77.5% reactor power with 0.5%/hr power ramp. The real plant data were collected from available on-line plant records and computer diagnostics. The transient was simulated by RELAP5/MOD2/36.05 and the results were compared with the plant data to assess the code weaknesses and strengths. Some nodalization studies were performed to contribute to developing a guideline for PWR nodalization for the transient analysis. 5 refs., 18 figs., 3 tabs.

28072 (NUREG/IA–0031) **ICAP [International Code Assessment and Applications Program] assessment of RELAP5/MOD2, Cycle 36.05 against LOFT [Loss of Fluid Test] Small Break Experiment L3-7.** Lee, Euy-Joon (Korea Advanced Energy Research Inst., Daeduk-Danji (Republic of Korea). Korea Nuclear Safety Center); Chung, Bud-Dong; Kim, Hho-Jung. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Korea Advanced Energy Research Inst., Daeduk-Danji (Republic of Korea). Korea Nuclear Safety Center. Apr 1990. 168p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A08/MF A01 - GPO; OSTI; INIS.

The LOFT small break (1 in-dia) experiment L3-7 has been analyzed using the reactor thermal hydraulic analysis code RELAP5/MOD2, Cycle 36.05. The base calculation (Case A) was completed and compared with the experimental data. Three types of sensitivity studies (Cases B, Cm, and D) were carried out to investigate the effects of (1) break discharge coefficient Cd, (2) pump two-phase difference multiplier and (3) High Pressure Injection System (HPIS) capacity on major thermal and hydraulic (T/H) parameters. A nodalization study (Case E) was conducted to assess the phenomena with a simplified nodalization. The results indicate that Cd of 0.9 and 0.1 fit to the single discharge flow rate of Test L3-7 best among the tried cases. The pump two-phase multiplier has little effects on the T/H parameters because of the low discharge flow rate and the early pump coast down in this smaller size SBLOCA. But HPIS capacity has a very strong influence on parameters such as pressure, flow and temperature. It is also shown that a simplified nodalization could accomodate the dominant T/H phenomena with the same degree of code accuracy and efficiency.

28073 (NUREG/IA–0032) **Assessment of RELAP5/MOD2, Cycle 36-04 using LOFT [Loss of Fluid Test] Large Break Experiment L2-5.** Bank, Young Seok (Korea Advanced Energy Research Inst., Daeduk-Danji (Republic of Korea). Korea Nuclear Safety Center); Lee, Sang Yong; Kim, Hho-Jung. Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research; Korea Advanced Energy Research Inst., Daeduk-Danji (Republic of Korea). Korea Nuclear Safety Center. Apr 1990. 181p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A09/MF A01 - GPO; OSTI; INIS.

The LOFT L2-5 LBLOCA Experiment was simulated using the RELAP5/MOD2 Cycle 36.04 code to assess its capability to predict the phenomena in LBLOCA. One base case calculation and three cases of different nodalizations were carried out. The effect of different nodalization was studied in the area of the downcomer and core. For a sensitivity study, another calculation was executed using an updated version of RELAP5/MOD2 Cycle 36.04. A Split downcomer with one crossflow junction and two core channels were found to be effective in describing the ECC bypass and hot channel behavior. And the updated version was found to be effective in overcoming the code deficiency in the interfacial friction and reflood quenching. 11 refs., 55 figs., 10 tabs.

28074 (ORNL/FTR–3592) **[Reliability of reactor pressure components]: Foreign trip report, March 12–30, 1990.** Pugh, C.E. Oak Ridge National Lab., TN (USA). 18 Apr 1990. 25p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. Order Number DE90009851. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the regular meeting of the IAEA IWG-RRPC as the US representative. The IWG-RRPC addresses R&D programs in the member countries relative to the reliability of passive and active pressure components of nuclear reactors. While not limited to light-water reactors (LWRs), most of the ongoing activities are related to LWRs. The scientific secretary reported on the two Specialists' Meetings held since the last IWG meeting in October 1988, and two others are to be held during the next six months. Specialists' Meetings were identified for each of the next four years, with one potentially planned to be held in the United States in 1992. Twenty-nine representatives from nineteen countries and associated programs attended the meeting. The traveler presented a summary of R&D programs in the United States with an emphasis on those of the Nuclear Regulatory Commission (NRC). In response to guidance from the IAEA, the IWG/RRPC examined how to shift its emphasis to aging phenomena and life extension for the whole of nuclear power plants. Accordingly, it was proposed to the IAEA that the IWG name he changed to Life Management of Nuclear Power Plants (IWG-LMNPP). Corresponding changes were proposed to the IWG's Terms of Reference.

28075 (SAND–89-2505C) **Continued research on the strain to failure of thick-walled cylinders subjected to internal pressure.** Roach, D.P.; Priddy, T.G. Sandia National Labs., Albuquerque, NM (USA). [1990]. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900617–6: Pressure vessels and piping conference: be in tune for the 90's, Nashville, TN (USA), 17-21 Jun 1990). Order Number DE90008952. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The determination of the fully plastic response and pressure limit of a pressure vessel is of considerable importance in design. In-house experience in weapon development, new aerospace applications and autofrettage operations all require in-depth knowledge of the strength of high pressure containment structures. This paper presents additional results to support the strain-to-failure analysis of thick-walled cylindrical vessels. Both aluminum and steel, with material properties ranging from ductile to brittle, were tested at stress levels through plastic and strain hardening ranges to fracture. From these tests, the pressure-expansion and through thickness yielding characteristics were determined for these specimens. The critical effective plastic strain depends on the level of tensile stress triaxiality which varies through the wall thickness. It is shown that the proposed strain-to-failure criterion is based on this triaxiality of stress in the critical region and can be used to predict the complete pressure versus strain relations and maximum pressure for the test cylinders. 17 refs., 12 figs.

28076 (WHC-SP–0001) **N Reactor limited-scope probabilistic risk assessment.** Westinghouse Hanford Co., Richland, WA (USA); Science Applications International Corp., Albuquerque, NM (USA). Jul 1987. 186p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90009493. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

This document reports the results of a Limited-Scope Probabilistic Risk Assessment (PRA) of N Reactor operation. The study has a three-fold purpose: support the overall N Reactor Confinement Effectiveness Study intended to provide a basis for comparison between a standard nuclear plant with containment and the N Reactor with confinement; provide early and conservative estimates of radiological risk from operation of N Reactor, using the best information available currently to assist decision makers as they examine questions pertaining to continued N Reactor operation; and identify the accident sequences that are principal contributors to radiological risk so that resources for the current full-scope PRA can be focused on analysis of these sequences. 66 refs., 49 figs., 23 tabs.

28077 (WHC-SP–0017-2) **Oxidation of N Reactor fuel under high-temperature accident conditions.** Birney, K.R. (Westinghouse Hanford Co., Richland, WA (USA)); Cronenberg, A.W. Westinghouse Hanford Co., Richland, WA (USA). Mar 1988. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90009488. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Tests conducted on N Reactor fuel elements heated to high temperatures in a flowing steam atmosphere have been reviewed to assess hydrogen generation from failed fuel. The hydrogen generation from oxidation of Zircaloy cladding and uranium fuel at the failure temperature and as a function of time is estimated. A correlation for use in subsequent deterministic analyses of N Reactor core behavior during postulated high-temperature degraded core accidents is presented. The results include an estimate of the amount of uranium surface area exposed to the oxidizing atmosphere as a function of time. 9 refs., 7 figs., 4 tabs.

28078 (WHC-SP–0096) **Hydrogen generation and thermal analysis of the hydrogen-mitigation design-basis accident: N Reactor safety enhancement, Final report.** Heard, F.J. (Westinghouse Hanford Co., Richland, WA (USA)); Ogden, D.M.; Lombardo, N.J.; White, M.D. Westinghouse Hanford Co., Richland, WA (USA). Dec 1987. 238p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90009491. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

Calculations were performed to determine core heatup and subsequent hydrogen production for a hypothetical severe accident at the US Department of Energy's N Reactor, located on the Hanford Site near Richland, Washington. The analysis was conducted to provide confirmation that the hydrogen source term assumed for the design of a hydrogen mitigation system was indeed conservative. The postulated accident sequence is initiated by a loss-of-coolant event, followed by the extremely unlikely failure of the emergency core-cooling system (ECCS). Under these conditions, core heatup is governed by the decay-heat rate and postulated chemical interactions offset by heat dissipation to the unique graphite and shield cooling system (GSCS). The GSCS can provide recirculating or once-through cooling through the central core region of the graphite stack. The GSCS served as the ultimate heat sink for this accident simulation. This report documents the approach and results of the analysis. 27 refs., 54 figs. , 11 tabs.

28079 (WHC-SP–0457) **Analysis of N Reactor anticipated transients without scram.** Sathyanarayana, K. (Pacific Northwest Lab., Richland, WA (USA)); Ogden, D.M. Westinghouse Hanford Co., Richland, WA (USA). Jul 1989. 170p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90009485. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This report documents the N Reactor thermal-hydraulic system response for the anticipated transients without SCRAM (ATWS). The N Reactor is a graphite-moderated, water-cooled pressure-tube reactor. The primary coolant is pumped through 1003 horizontal pressure-tubes which contain two concentric tubular metallic fuel elements. The calculations were performed using RELAP5/MOD2 computer code. RELAP5/MOD2 is a best-estimate, two-phase, full six-equation, nonequilibrium, and nonhomogeneous thermal-hydraulic computer code designed for pressurized water reactor transients. A point-reactor kinetics model with reactivity feedback was employed to compute the power generated in the reactor core. The transients simulated were 200% double-ended guillotine break in the cold-leg manifold and the station blackout with the simultaneous failure of SCRAM and emergency core cooling system (ECCS) and the loss of ac power. In all the transients, the loss of high pressure injection system (HPI), the complete loss of graphite and

shield cooling system (GSCS) and the isolation of steam generator secondary were included. Also, the ATWS transient, due to the 200% guillotine break of the cold-leg manifold assuming the availability of ECCS from three high-lift diesel pumps operating at full capacity and the loss of ac power, was analyzed. These three transients were first evaluated using the void feedback reactivity having an absolute level of −167 mk corresponding to an infinite lattice MK IV fuel. Then these transients were reevaluated using a more realistic void feedback reactivity having an absolute level of −70 mk. The report includes brief descriptions of the N Reactor, the computer code, the thermal-hydraulic plant model used in the simulations and the discussion of results. 12 refs., 113 figs., 13 tabs.

28080 Trends and underlying practices in occupational exposures in the nuclear power industry. Cohn, J.I. (Electric Power Research Institute, Palo Alto, CA (USA)); Wood, C.J. pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

Three factors govern the radiation exposures in nuclear power plants: (1) radiation field levels, (2) the need to enter these fields to do work and surveillance, and (3) the productivity of workers while in radiation fields. Recent dose trends are evidence of some success in controlling the above factors. Exposure per plant has fallen in each of the past three years. The geometric mean of collective exposures for 1983 through 1986 are (for BWRs): 1,533, 840, 680 and 530 man-rem/plant. The values for PWRs are: 500, 440, 395 and 320 man-rem/plant. Collective exposures in 1986 totaled 42,725 man-rem.

28081 Radiation exposures in the nuclear maintenance and service industry. Haertjens, B.L. (Westinghouse Electric Corp., Pittsburgh, PA (USA)); Lim, B.B. pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

The recent experience of the Energy Systems Service Division of Westinghouse Electric Corporation indicates that the general trend of radiation exposures in the nuclear maintenance and service industry is favorable and on the edge of a long-sought downward trend. Exposure data obtained over the past six-year period (1980-1986) has been analyzed. Annual exposure for a variety of service job categories shows the positive effect of increased training of service workers and enhancement of service equipment in the reduction of radiation exposure. Service Resource Planning is required to ensure the continuation of radiation exposure reduction in the industry.

28082 Nuclear liability interest in population and environmental exposures from the nuclear fuel cycle. Piccolo, R.G. (American Nuclear Insurers, Farmington, CT (USA)). pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

The potential for costly nuclear liability claims is often a hidden dimension to the operation of a nuclear power plant. There are two predominant modes for this to occur: either from on-site exposures to plant workers and alleged bodily injury; or from the release of plant effluents to the environment and alleged property damage and bodily injury. ANI/MAELU recently received 2 multi-million dollar nuclear liability claims alleging environmental damage caused by the routine release of radioactive effluents from nuclear facilities. In both cases, the release of radionuclides appeared to be within appropriate regulations. Two important goals of the regulations are to monitor releases and to ensure that releases are within limits intended to protect the public. While, in fact radionuclide releases are normally within regulatory limits, this does not address the growing perception that radiation at any level is harmful. ANI/MAELU is concerned because this perception impacts the possibility of tort litigation. ANI/MAELU conducted a partial review of the nuclear industry environmental monitoring programs. One general conclusion of this effort is that the industry is adequately monitoring environmental releases, thereby protecting the public. They have also generally concluded that the industry is not well poised to protect itself from some of the consequences of potential liability claims alleging property damage or bodily injury from radiation released to the environment. ANI/MAELU Bulletin 86-1, Environmental Monitoring Programs was issued in February of 1986 addressing this concern. The Bulletin identifies five areas where improvements can be made in environmental monitoring programs to reduce the potential for litigation.

28083 Acoustoelastic response from the velocities of ultrasonic plate modes. Lee, S.S. (Korea Standards Research Institute, Chungnam (KR)); Smith, J.F.; Thompson, R.B. pp. 686 of Proceedings of the 9th international conference on nondestructive evaluation in the nuclear industry. Iida, K.; Doherty, J.E.; Edelmann, X. American Society for Metals, Metals Park, OH (USA) (1988). (CONF-880471–: 9. international conference on nondestructive evaluation in the nuclear industry, Tokyo (Japan), 25-28 Apr 1988).

Ultrasonic stress determination is based on the assumed linear relationship between the velocity of an ultrasonic wave and the stress in the material. Although changes in stress are routinely monitored, the absolute determination of stress in a part of unknown history is rendered difficult by competing microstructurally induced velocity shifts. Measurement of the velocity of two shear waves whose directions of propagation and polarization have been interchanged has been known as a possible solution to overcome the above problem. Experimental results to assess the microstructure effect on the acoustoelastic constants are shown. The data show that, whereas the individual velocities are strongly influenced by microstructure, the acoustoelastic constants based on the above possible solution are not influenced by microstructure.

28084 The major result of the PISC RRT on cast stainless steel components. Doctor, S.R. (Pacific Northwest Lab., Richland, WA (USA)); Jehenson, P. pp. 686 of Proceedings of the 9th international conference on nondestructive evaluation in the nuclear industry. Iida, K.; Doherty, J. E.; Edelmann, X. American Society for Metals, Metals Park, OH (USA) (1988). DOE Contract AC06-76RL01830. (CONF-880471–: 9. international conference on nondestructive evaluation in the nuclear industry, Tokyo (Japan), 25-28 Apr 1988).

This paper presents the results of the Centrifugally Cast Stainless Steel Round Robin Test (CCSSRRT). The CCSSRRT is the first phase of an effort to investigate and improve the capability and reliability of NDE inspections of light water reactor piping systems. This phase was a screening test to identify the most promising procedures presently available for CCSS. It was anticipated that the anisotropic and coarse-grained structure of the specimens would make proper classification of the material difficult. Because of this, measurement of each team's performance included summaries of their results in both cracked and uncracked material. The results of the CCSSRRT make it apparent that a more detailed study on the capability and reliability of procedures to inspect stainless steel materials is needed to better understand the specific material and flaw properties.

28085 Advanced methods comparisons of reaction rates in the purdue fast breeder blanket facility. Hill, R.N. (Argonne National Lab., IL (USA). Engineering Div.); Ott, K.O. *Nuclear Science and Engineering (USA)*, 103(1): 12-24 (Sep 1989).

The authors discuss how experiments in the large uniform Purdue University fast breeder blanket facility blanket yield an accurate quantification of this discrepancy. Using standard production code methods (diffusion theory with 50-group cross sections), a consistent calculated-to-experimental (C/E) drop-off is observed for various reaction rates. A 50% increase in the calculated results at the outer edge of the 51-cm blanket is necessary for agreement with experiments. The usefulness of refined group constant generation, utilizing speciaized weighting spectra, and transport theory methods in correcting this discrepancy is analyzed. Refined group constants reduce the discrepancy to half that observed using the standard method. The result is that transport methods have no

effect on the blanket deviations; thus, the present multigroup transport theory does not constitute or even contribute to an explanation of the blanket discrepancies. The residual blanket C/E drop-off (about half the standard drop-off) using advanced methods must be caused by approximations that are applied in all current multigroup methods.

28086 The interaction of fast neutrons with beryllium. Sugimoto, M. (Argonne National Lab., IL (USA). Engineering Div. (USA)); Guenther, P.T.; Lynn, J.E.; Smith, A.B.; Whalen, J.F. *Nuclear Science and Engineering (USA)*, 103(1): 37-45 (Sep 1989). DOE Contract W-31-109-ENG-38.

Neutron total cross sections of elemental beryllium are measured from 1 to 10 MeV with good precision. Differential neutron elastic scattering cross sections are measured from 4.5 to MeV at intervals of ≈0.5 MeV and at ≈100 angular steps distributed between ≈18 and 160 deg at each incident energy. Concurrently, differential cross sections for the emission of a discrete inelastic neutron group corresponding to an excited level at (2.43 ± 0.06) MeV are determined over the same incident energy and angular range. Angle-integrated elastic scattering cross sections are deduced from the observed differential values to accuracies of ≈2l5%, and angle-integrated inelastic scattering cross sections to accuracies of ≈10%. The experimental results are compared with values given in ENDF/B-V, with attention to descrepancies and implications. Qualitative reaction mechanisms are suggested.

28087 Compact nuclear power source critical experiments and analysis. Hansen, G.E. (Los Alamos National Lab., NM (USA)); Palmer, R.G. *Nuclear Science and Engineering (USA)*, 103(3): 237-246 (Nov 1989).

Critical experiments have been performed on a mock-up of the compact nuclear power source (CNPS), a small reactor system designed to provide power at sites where fuel costs and logistics make fossil-fuel-powered systems less attractive. Although the program has been canceled, its unique physics characteristics make the CNPS a useful benchmark for medium-enriched uranium-graphite-moderated reactors. The physical design, details of the critical experiments, and the methods and results of the analysis are described. The discrepancies between calculations and experiments are such that, though further modeling work is necessary to delineate the causes, the beginning-of-life performance of the reactor was adequately predicted.

28088 Experiments and analysis for an axially heterogeneous liquid-metal reactor assembly at the zero-power physics reactor. Brumbach, S.B. (Argonne National Lab., Idaho Falls, ID (USA)); Collins, P.J. *Nuclear Science and Engineering (USA)*, 103(3): 219-236 (Nov 1989).

Experiments in zero-power physics reactor 17 provided physics data for a full-scale axially heterogeneous 650-MW(electric) liquid-metal reactor. Measurements and analysis are reported for control rod worths, reaction rate distributions, gamma dose distributions, sodium void worths, and criticality. Agreement between measurement and calculation is generally satisfactory, but the axial heterogeneity did introduce analytical complications. Design-level calculation methods gave somewhat worse agreement with measurement than in previous homogeneous or radially heterogeneous assemblies.

24 POWER TRANSMISSION AND DISTRIBUTION

Refer also to citation(s) 28776

2401 Power Systems

Refer also to citation(s) 27896, 28192

28089 (EPRI-EL–6796) **Knowledge-based system for direct stability analysis: Final report.** El-Kady, M.A. (McMaster Univ., Hamilton, ON (Canada)); Fouad, A.A.; Liu, C.C. Electric Power Research Inst., Palo Alto, CA (USA); McMaster Univ., Hamilton, ON (Canada). c Apr 1990. 104p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The objective of the project is to investigate the application of the Transient Energy Function (TEF) method of transient stability analysis to power system dynamic security assessment using Expert System technology. The investigation covers the following areas: type and requirements of the knowledge base structure of the TEF-Expert System; use of the artificial intelligence concepts in processing TEF results for security-related decisions; and identification of the developments needed for successful implementation of a TEF-Expert scheme in an Energy Management System (EMS) of a stability-limited power network. The operator requirements in dynamic security assessment which can be addressed by Expert Systems were first identified and studied. This was followed by a comprehensive assessment of the TEF method capabilities which can be utilized to meet such requirements. The development of the TEF-Expert System was then carried out which includes description of the TEF knowledge base, the application rules, parameters, etc. Sample applications of the proposed technique have been considered for two North American power networks: a stability-limited, transmission constrained, area of Ontario Hydro system; and the transient-voltage-limited network of Northern States Power Company. The successful results achieved in the current project and the resolution of pertinent issues and problems have advanced the state of the art in dynamic security assessment and increased the level of understanding of the operators needs and problems which can be addressed by TEF Expert Systems. It is now believed that the development of a general large-scale implementation of the TEF-based Expert System is both achievable and beneficial in providing an advanced, artificial intelligence based capability to existing Energy Management Systems (EMS).

2402 Power System Networks, Transmission and Distribution

Refer also to citation(s) 28191, 28232

28090 (DOE/CE/34025–T3) **Studies of 60-Hz exposure effects on human function: Quarterly report No. 3, January 1, 1990–March 31, 1990.** Midwest Research Inst., Kansas City, MO (USA). 16 Apr 1990. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-89CE34025. Order Number DE90009473. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Public concern has been expressed about possible health risks arising from exposure to the electric and magnetic fields generated by power distribution systems. This project is addressing this concern through a laboratory research program designed to evaluate the effects of brief exposure to known field conditions on multiple measures of human function. In previous research, we found that such exposure had statistically significant effects on physiological measures of cardiac and brain activity, and on performance measures of reaction time and performance accuracy. These effects were seen more clearly under intermittent exposure conditions, and at certain levels of electric and magnetic field strength. In the current effort, we plan to perform a series of exploratory studies, followed by a confirmatory experiment, to determine if the above physiological effects differ as a function of exposure to the electric and magnetic fields separately and combined, time of day, and rate of intermittent exposure. Further studies will explore the mechanisms underlying these effects. The information developed in this project will be of value in risk assessment, and in basic research programs aimed at identifying specific factors involved in the interaction of powerline fields with the human system. During the present reporting period, funding was awarded to continue this research effort at a reduced level until December 31, 1990. Our goals for this reporting period were to: complete exploratory Study 1; participate in a project review meeting at MRI; and begin additional exploratory studies.

28091 (EGG-EE–8651) **PCB [polychlorinated biphenyl] sampling of transformers and electrical devices at Norfolk Naval Base, Norfolk, Virginia.** McBride, S.A. EG and G Idaho, Inc., Idaho Falls, ID (USA). Mar 1990. 158p. Sponsored by U.S.

Department of Defense. DOE Contract AC07-76ID01570. Order Number DE90009790. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

In 1988 a program was conducted on the Norfolk Naval Base to sample all of the liquid-filled transformers and other electrical devices. This task was part of the Utility Research and Modernization Program. The objectives of the program were as follows: identify the devices as non-polychlorinated biphenyl (PCB), PCB-filled, or PCB-contaminated; identify the technical, logistical, and operational problems that could possibly be encountered should the Navy implement a large-scale device sampling program; perform life expectancy analysis on mission essential devices; and construct a certified data base of PCB devices. This report details the work performed and PCB data obtained and summarizes the lessons learned during the Norfolk Naval Base Sampling program. The program was a success; however, several recommendations are made for future work of this nature at other sites.

28092 (EPRI-EL–6762) **Proceedings: Transmission and distribution automation systems.** Electric Power Research Inst., Palo Alto, CA (USA); Electric Research and Management, Inc., State College, PA (USA). c Mar 1990. 537p. Sponsored by Electric Power Research Institute. (CONF-8905306–: Transmission and distribution automation systems conference, King of Prussia, PA (USA), 22-24 May 1989). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The EPRI-sponsored seminar on Transmission and Distribution Automation provided the participants with information on the conception, development and design, and implementation of systems employing digital technology and fiber optics for integrated system for protection, control, monitoring, and communication in substations. Eighty engineers from utilities, suppliers, and consultants attended the seminar. Twenty-five papers were presented and discussed at the seminar. Demonstrations of developed equipment were held at the seminar site and at two host utilities where transmission substation automation systems have been installed. Each report will be automated individually.

28093 (EPRI-EL–6764) **Study of improved load-tap-changing for transformers and voltage regulators: Final report.** Gilker, C. (Cooper Industries, Inc., Franksville, WI (USA). Thomas A. Edison Technical Center). Electric Power Research Inst., Palo Alto, CA (USA); Cooper Industries, Inc., Franksville, WI (USA). Thomas A. Edison Technical Center. c Apr 1990. 97p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report covers a feasibility study of load tap changers (LTC) used at both the transmission and distribution levels. The study included a search of published and patented material, utility and manufacturer visits, a tabulation of a number of concepts to improve reliability, reduce manufacturing costs, and minimize operating losses, a review of retrofitting new design LTCs into old LTC applications and an engineering effort to detect wear-out and failures from both a general view point and a practical application. No interesting obscure information resulted from the search of the published material. Many concepts for LTCs have been offered in published form and in marketed products. Of those introduced to the market most failed due to a lack of ruggedness and operating life required by electric utilities. The utility and manufacturer visits emphasized the need for an improvement in the reliability and a major improvement in the life of the typical LTC now in use, but acknowledged strong economic pressures preventing expenditure for these improvements. The concepts tabulated related to the LTC's reliability, costs and losses had little to offer to a product as mature as an LTC. Although the design is not fluid, there are a continuing series of improvements appearing in LTCs. The feasibility of measuring wear-out or predicting failure in an operating load tap changer was investigated. A transducer working with a microcomputer was evaluated to monitor normal and abnormal vibrations or mechanical noise in an effort to detect an unhealthy LTC. The need for this concept was mitigated by some utilities belief that LTCs can be built to be reliable during their operating life, and thus not need a monitor to detect any developing problems.

28094 (EPRI-EL–6794) **Demonstration of a two-phase cooled power transformer: Final report.** Savio, L.J. (Consolidated Edison Co. of New York, Inc., New York, NY (USA)). Electric Power Research Inst., Palo Alto, CA (USA); Consolidated Edison Co. of New York, Inc., New York, NY (USA). c Apr 1990. 46p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report describes the design, manufacture, test installation and operation of a 138/13.8 kV, 65 MVA two-phase cooled power transformer developed by Westinghouse. The transformer was installed on the Consolidated Edison system in the Seaport Substation in 1986 and is presently in service. The demonstration installation and operation experience is described.

28095 (ORNL/FTR–3583) **[Power sector efficiency analysis in Costa Rica]: Foreign trip report, March 19, 1990–March 31, 1990.** Waddle, D.B. Oak Ridge National Lab., TN (USA). 10 Apr 1990. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90009849. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

I traveled to San Jose, Costa Rica, to review the state of the electric power utility with a team of specialists, including a transmission and distribution specialist, a hydroelectric engineering specialist, and a thermal power plant specialist. The purpose of the mission was to determine the costs and benefits of efficiency improvements to supply side technologies employed by the Instituto Costarricense de Electricidad, the national power company in Costa Rica, and the potential contribution of these efficiency measures to the future electric power needs of Costa Rica.

2403 Power Transmission Lines and Cables

Refer also to citation(s) 27877, 28092

28096 (EPRI-EL–6607) **Conductor fatigue life research: Final report.** Springfield, C.W. (Auburn Univ., AL (USA). Engineering Experiment Station); Ramey, G.E. Electric Power Research Inst., Palo Alto, CA (USA); Auburn Univ., AL (USA). Engineering Experiment Station. c Mar 1990. 590p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This is the final report of Phase 4 of Research Project RP 1278-1 sponsored by the Electric Power Research Institute and carried out at the Civil Engineering Department of Auburn University and United Power Association (UPA) in Elk River, Minnesota. The primary objectives of this Phase 4 work were to: monitor transmission line vibration and site wind activities at various sites to evaluate the effects of terrain, windfield and season of the year on line "load"-N curves, and to evaluate correlations between line vibration and site wind activities; experimentally evaluate appropriate S-N curve modification factors for different transmission line conductor types, line conditions and clamp conditions; investigate and develop an improved dynamic bending stress equation for predicting aeolian fatigue stresses in the strands of multistranded overhead conductors; experimentally refine the level of amplitude reduction required to arrest significant further fatigue damage to conductors that are already minimally damaged; and study and evaluate interactions between wind, conductor vibrations, support hardware vibrations and support tower vibrations for a 2-conductor bundle transmission line located at a very active wind site.

28097 (EPRI-EL–6771-Vol.1) **Three-conductor compressed-gas cable field demonstration: Volume 1: Manufacture and installation, Final report.** Bolin, P.C. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Transmission and Distribution Components Div.); Cookson, A.H.; Dale, S.J.; Hopkins, M.D. Electric Power Research Inst., Palo Alto, CA (USA); Westinghouse Electric Corp., Pittsburgh, PA (USA). Transmission and Distribution Components Div. c Mar 1990. 75p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Development of an EHV three-conductor SF_6 insulated transmission system has progressed to the stage where a field

demonstration has been initiated. Details of the 362 kV SF_6 insulated transmission line system design and manufacture are presented. The installation and field test program of a 180 m (600 ft) test loop at the Detroit Edison Company, Wayne Street Station are described. An instrumentation system for a long range test program is also discussed and the test program outlined. 7 refs., 63 figs., 3 tabs.

28098 (EPRI-EL–6771-Vol.2) **Three-conductor compressed-gas cable field demonstration: Volume 2, Testing: Final report.** Corbett, J.T. (Detroit Edison Co., MI (USA). Power System Organization); Brown, J.L.; Marchlewski, J.H.; Edwards, D.B. Electric Power Research Inst., Palo Alto, CA (USA); Detroit Edison Co., MI (USA). Power System Organization. c Mar 1990. 40p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

Development of an EHV three-conductor SF_6 insulated transmission system has progressed to the stage where a field demonstration has been completed. Details of the three in one 362 kV SF_6 insulated transmission line operation during a three year period are presented. A 180 m (600 ft) test loop was installed at the Detroit Edison Company, Wayne Station. Any user of such a system should be aware of the high probability that any fault during operation will be three phase and that the system tends to be mechanically fragile.

28099 (PB–90-860305/XAB) **Extra-high-voltage power transmission. December 1973-December 1989 (A Bibliography from the NTIS database). Report for December 1973-December 1989.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 133p. Available from NTISPC N01/MF N01.

Supersedes PB–85-872000.

This bibliography contains citations concerning the design, construction, and use of extra-high-voltage power transmission lines. Both underground and overhead lines are discussed, as well as superconducting and resistive cryogenic lines. Health, safety, and psychological aspects of the electrical field, corona, ozone, and acoustic effects of these lines are discussed. New conductors, insulators, mounting, monitoring, control, and lightning protection of EHV power transmission lines are presented. (This updated bibliography contains 265 citations, 56 of which are new entries to the previous edition.)

28100 Accuracy of approximate transmission line formulass for overhead wires. Chen, K.C. (Electromagnetic Analysis Div., Sandia National Labs., Albuquerque, NM (US)); Damrau, K.M. *IEEE Transactions on Electromagnetic Compatibility (Institute of Electrical and Electronics Engineers) (USA),* 31(4): 396 (Nov 1989).

Errors resulting from two approximations of the transmission line parameters of overhead wires are determined. Sunde's simple approximation is found to be more accurate than the Handel function approximation.

28101 An experimental test of a theory of lighting-induced voltages on an overhead wire. Rubinstein, M. (Univ. of Florida, Dept. of Electrical Engineering, Gainesville, FL (US)); Uman, M.A.; Medelius, P.J.; Thomson, E.M.; Tzeng, A.Z. *IEEE Transactions on Electromagnetic Compatibility (Institute of Electrical and Electronics Engineers) (USA),* 31(4): 376-383 (Nov 1989). Contract NAS10-11272.

Measured and calculated voltages induced on an unenergized overhead power line by lightning return strokes at distances greater than 5 km from the line are presented. The experiment was performed at the NASA Kennedy Space Center during the summer of 1985 and involved the simultaneous measurement of the voltage induced at one end of the top phase of a three-phase power line and the two horizontal components of the return-stroke magnetic field incident on the line. The calculation of induced voltage was performed using a time-domain model. Inputs to the model were the incident vertical and horizontal electric fields, which were derived by theory from the measured incident magnetic fields and the effective ground conductivity. The effective ground conductivity was determined from previous simultaneous measurements of the vertical and horizontal electric fields. Experiments were performed for two cases: all phases of the power line open circuited and one end of the top line terminated at 600 Ω with the other end open circuited and the other two phases open circuited at both ends. The waveshapes of the measured and calculated voltages are in reasonably good agreement, and the reasons for observed discrepancies are discussed.

2404 Health and Safety

Refer also to citation(s) 28101, 28103

28102 (UCRL–102857) **Preplacement testing pilot program.** Bockrath, C.; Halunen, L. Lawrence Livermore National Lab., CA (USA). 1 Feb 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9006132–1: Annual international industrial ergonomics and safety conference, Montreal (Canada), 10-13 Jun 1990). Order Number DE90008319. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper is aimed at those interested in instituting physical ability testing programs. It describes the general methodology used and lessons learned in initiating a pilot program for preplacement testing in a research and development facility. It is anticipated that the job analyses and testing criteria produced by our program will have additional applications in rehabilitation, recruiting, and worker hardening. 9 refs., 2 tabs.

2405 Environmental Aspects

Refer also to citation(s) 28099, 28101

28103 (EPRI-EL/GS/EN–6792) **Proceedings: 1989 EPRI PCB seminar.** Addis, G. (ed.). Electric Power Research Inst., Palo Alto, CA (USA). c Apr 1990. 409p. Sponsored by Electric Power Research Institute. (CONF-8910275–: 1989 Electric Power Research Institute PCB seminar, San Diego, CA (USA), 3-6 Oct 1989). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The 1989 PCB seminar continued EPRI's series providing timely information and training on PCB regulation, research and management for utilities, regulators and contractors. The papers provided a broad mix ranging from fundamental research to capability for immediate commercial application. A new feature was the session on problems of the gas utilities; Subjects covered during the three and one-half day meeting were: regulations, spills, carcass disposal, retrofill and reclassification, risk, PCB fires, PCB analysis, problems of the gas utilities, health effects, international, decontamination of oil and destruction of PCB, and substitute fluids. Each report will be cataloged individually.

2406 Legislation and Regulations

Refer also to citation(s) 28103

2407 Economic, Industrial, and Business Aspects

Refer also to citation(s) 28195

25 ENERGY STORAGE

2506 Thermal

Refer also to citation(s) 28230, 28280

28104 (CONF-9004176–1) **Government-sponsored research in thermal energy storage.** Tomlinson, J.J. Oak Ridge National Lab., TN (USA). [1990]. 17p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From ETS/TES 1990 conference on thermal storage; Washington, DC (USA); 10 Apr 1990. Order Number DE90009862. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Responding to energy supply disruptions during the last decade, the US Government began a program to research and develop thermal energy storage (TES) media and systems that could used

to shift fuel use from imported oil and gas to other indigenous energy resources including renewables. Due to its flexibility in matching time-varying energy supplies with demand and capturing low availability waste heat, TES offers a means of increasing the efficiency of many heating and cooling systems for the industrial and commercial sectors. Today, a Federal presence in TES research and development is continuing to help resolve national and global issues such as energy-related environmental problems, growing reliance on imported oil, a projected electrical capacity shortfall, and flagging US competitiveness in international markets. This Federal role in TES research is described; results of research, development, and evaluation of TES technologies that reduce energy consumption and facilitate electric load management are also presented. 7 refs., 2 figs.

28105 **Development of encapsulated lithium hydride thermal energy storage.** Olszewski, M. (Oak Ridge National Lab., TN (USA)); Siman-Tov, M. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 6. IEEE Service Center, Piscataway, NJ (USA) (1989). DOE Contract AC05-84OR21400. (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899640.

The authors discuss a packed bed thermal energy storage (TES) unit using encapsulated LiH spheres proposed as a means of reducing the mass and size of space-based heat rejection systems in applications with pulsed power needs. Value assessment of the concept indicated that mass and area savings are possible for applications having power generation periods as long as 1600 s. The major area of technical uncertainty is associated with shell stresses during heating when the melting (and expanding) LiH at the shell surface is trapped between the encapsulating shell and the solid LiH core. A series of feasibility tests demonstrated that the LiH cracks during cooldown and that the melting LiH uses these paths to communicate with the central void during charging. Feasibility of the concept was proven conclusively in the reliability demonstration (RD) test series when the 50-mm diameter encapsulated LiH test article completed to date indicates that the proposed TES system has merit for pulsed space power systems and the encapsulated LiH concept is feasible.

2509 Batteries

Refer also to citation(s) 28970

28106 (AD-A–216575/1/XAB) **Feasibility of a superhigh energy-density battery of the Li/BrF_3 electrochemical system. Progress report, 15 October-15 December 1989.** Pyszczek, M.F.; Ebel, S.J.; Frysz, C.A. Greatbatch (Wilson) Ltd., Clarence, NY (USA). 15 Dec 1989. 20p. (WGL-MLR–89-41). Available from NTIS, PC A03/MF A01.

The feasibility of developing a lithium/bromine trifluoride battery is being studied. Critical to this product development is materials selection. Consequently, efforts have been directed toward identifying candidate porous electrode separators, glasses for insulated electrical feed-throughs and metals for lid, case, and current-collector fabrication. Samples were evaluated via electrochemical testing techniques and one month storage in Teflon vials. Vial test results for metal samples did not vary significantly from those reported in technical report 0001AA. Of the separator samples tested, Raychem proves to be most promising. Further study is required regarding glass selection. Electrochemical testing is still in progress.

28107 (AD-A–216794/8/XAB) **Feasibility of a superhigh energy-density battery of the Li/BrF_3 electrochemical system. Technical report.** Pyszczek, M.F.; Ebel, S.J.; Frysz, C.A. Greatbatch (Wilson) Ltd., Clarence, NY (USA). 1989. 15p. (WGL-MLR–89-30). Available from NTIS, PC A03/MF A01.

To date, design and construction of a material-handling and measurement system along with the apparatus required for waste material disposal has been completed. Preliminary corrosion screening of potential case materials is currently underway. A review of the literature, has led us to the use of Monel (trademark) 400 as the material of construction for the handling and measurement system. The inherent stability of this material with bromine trifluoride in its liquid state is crucial to ensure that contamination does not occur during storage and handling. For applications which require a flexible or transparent material, items fabricated from perfluoroalkyoxy polymers (Teflon) (trademark PFA) were utilized. One such application encountered was in the design of the graduated tank which allows visual inspection of the material prior to dispensing. Containers used for compatibility/corrosion testing were also constructed of PFA.

28108 (EGG-EP–8917) **Laboratory testing of Saft SEH-5-200 6 volt traction battery.** Hardin, J.E. EG and G Idaho, Inc., Idaho Falls, ID (USA). Dec 1989. 23p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009787. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this report is to describe the testing performed on the Saft SEH-5-200 flooded nickel cadmium traction battery by the INEL Electric Vehicle Battery Laboratory, to present the results and conclusions of this testing, and to make appropriate recommendations. 17 figs., 3 tabs.

28109 (EGG-EP–8918) **Laboratory testing of Energy Research Corporation ERC 160 NICd 6 volt traction battery.** Hardin, J.E.; Knauts, H.E. EG and G Idaho, Inc., Idaho Falls, ID (USA). Dec 1989. 31p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-76ID01570. Order Number DE90009629. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this report is to describe the testing performed on the Energy Research Corp. NiCd 160 nickel-cadmium 6 volt traction battery by the INEL Electric Vehicle Battery Laboratory, to present the results and conclusions of this testing, and to make appropriate recommendations. 15 figs., 2 tabs.

28110 (PB–90-860396/XAB) **Battery electrodes. January 1975-May 1987 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1975-May 1987.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 130p. Available from NTISPC N01/MF N01.

See also PB–90-860404.

This bibliography contains citations concerning properties and performance of battery electrode materials. Electrochemical and thermodynamic behavior, surface analysis, and materials tests are discussed. Discharge characteristics, electrode corrosion and kinetics, recharging features, and x-ray analyses are considered. (This updated bibliography contains 261 citations, none of which are new entries to the previous edition.)

28111 (PB–90-860404/XAB) **Battery electrodes. June 1987-January 1990 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for June 1987-January 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 121p. Available from NTISPC N01/MF N01.

Supersedes PB–87-860789. See also PB–90-860396.

This bibliography contains citations concerning properties and performance of battery electrode materials. Electrochemical and thermodynamic behavior, surface analysis, and materials tests are discussed. Discharge characteristics, electrode corrosion and kinetics, recharging features, and x-ray analyses are considered. (This updated bibliography contains 200 citations, all of which are new entries to the previous edition.)

28112 (SAND–89-2313C) **Aging characteristics of Li/SO_2 cells.** Levy, S.C.; Bouchard, D.A. Sandia National Labs., Albuquerque, NM (USA). [1990]. 6p. Sponsored by National Aeronautics and Space Administration. DOE Contract AC04-76DP00789. (CONF-9006146–2: 34. international power sources symposium, Cherry Hill, NJ (USA), 25-28 Jun 1990). Order Number DE90009333. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Delays in the launch of the Galileo probe to Jupiter have resulted in a new trajectory that will increase the fly-out time such that batteries will be greater than seven years old at the time of descent into the Jovian atmosphere. The longest real time data for

flight design cells was five years at the time of launch. A program was initiated to establish a methodology and data base so that the performance of these cells may be predicted at the time they are expected to complete the mission. Cells from five lots and five storage temperatures, ranging from one year to seven years in age, were studied. Chemical analysis was performed on one cell from each lot/storage group. The remaining cells in each group were discharged at the mission load and temperature. Additional cells were placed on high temperature accelerated storage, and then discharged. 2 figs., 1 tab.

28113 (SAND–89-2567C) **Voltage delay in Li/$SOCl_2$ cells for artillery applications at −35°C.** Delnick, F.M.; Baldwin, A.R. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9006146–1: 34. international power sources symposium, Cherry Hill, NJ (USA), 25-28 Jun 1990). Order Number DE90009282. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Sandia National Laboratories is developing active Li/$SOCl_2$ cells for use in Artillery-Fired Atomic Projectiles. Voltage delay is the primary mode of electrochemical failure in these cells at −35°C. To minimize this anode polarization, the anode passivation is inhibited by adding chloromethyl chlorosulfate (CMCS) to the sulfur dioxide complex of lithium tetrachloroaluminate ($LiAlCl_4 \cdot SO_2$) in the cell electrolyte. 3 refs., 5 figs.

28114 On the mechanism of $SOCl_2$ reduction in lithium cells. Szpak, S. (Naval Ocean Systems Center, San Diego CA (US)); Mosier-Boss, P.A.; Smith, J.J.; Nowak, R.J. pp. 408 of Proceedings of the symposium on materials and processes for lithium batteries. Abraham, K.M.; Owens, B.B. The Electrochemical Society, Pennington, NJ (USA) (1989). (CONF-8810205–: Symposium on materials and processes for lithium batteries, Chicago, IL (USA), 9-14 Oct 1988).

The reaction path of the $SOCl_2$ reduction from electrolytes containing dissolved $AlCl_3$, with and without the addition of LiCl, is examined by IR-reflectance spectroscopy and cyclic voltammetry. The IR- spectroscopic investigation provides information on the sequence the various $SOCl_2$ - bearing species are reduced. In particular, onium ions accept electrons at low overpotentials while the $Li(\leftarrow OSCl_2)_2^+$ species require an overpotential in excess of 1.0 V for the reduction to occur. The importance of the interplay between participating processes and the charge transfer is indicated by the scan rates and the shape of voltammograms as a function of concentration of the electroactive species.

28115 Electrocatalysis of anodic oxygen-transfer reactions: Chloride-doped lead dioxide electrodes. Hsiao, Y.L. (Dept. of Chemistry and Ames Lab., Iowa State Univ., Ames, IA (USA)); Johnson, D.C. *Journal of the Electrochemical Society (USA)*, 136(12): 3704-3710 (Dec 1989). DOE Contract W-7405-ENG-82.

The electrocatalytic activities were compared for pure and chloride-doped beta-PbO_2 films on gold and platinum substrates. Rate constants were increased significantly for oxidations of Mn^{2+}, toluene, benzyl alcohol, dimethylsulfoxide and benzaldenhyde in acidic media by the incorporation of Cl^- into the oxide films. These reactions are concluded to occur by the electrocatalytic transfer of oxygen fro H_2O to the reaction products. Results of x-ray diffraction studies indicate the Cl^- - doped PbO_2 continues to have the slightly distorted rutile structure of pure beta-PbO_2. The observed electrocatalytic phenomena is concluded to be the beneficial consequence of surface defects generated when Cl^- serves for charge compensation within the surface matrix and, thereby, increases surface sites capable of adsorbing hydroxyl radicals which are transferred in the electrocatalytic O-transfer reactions.

2510 Economic, Industrial, and Business Aspects

Refer also to citation(s) 28122

29 ENERGY PLANNING AND POLICY

Refer also to citation(s) 29903

28116 (DOE/OR/21400–T418) **International science and technology policies: Testimony before the Subcommittee on International Scientific Cooperation, Committee on Science, Space, and Technology, United States House of Representatives, April 4, 1990.** Trivelpiece, A.W. Oak Ridge National Lab., TN (USA). [1990]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009416. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper reflects testimony before a congressional committee on International Science and Technology Policies. (FSD)

2901 Energy Analysis and Modeling

Refer also to citation(s) 27876, 28203, 28296

28117 (DOE/BP/63406–4) **Climate change in the Pacific Northwest and its impact on energy planning: Preliminary report of findings: Appendix, Severe climate in the Pacific Northwest: Final.** Wade, J.E.; Wittrup, R.; Redmond, K.; Buckley, J. Oregon State Univ., Corvallis, OR (USA). Wind Resources Assessment Lab. Sep 1987. 71p. Sponsored by U.S. DOE Management & Administration. DOE Contract BI79-86BP63406. (BPA–87-26-App.). Order Number DE90009463. Available from NTIS, PC A04/MF A01 - OSTI.

The "Climatological Handbook, Columbia Basin States" (Environmental Science Services Administration) outlines extreme weather occurrences in the Pacific Northwest from the time records were dept up to December 1968. In the Climatological Handbook severe weather occurrences are categorized by wet spells, droughts, hot spells, cold spells and various storms (wind, snow, rain, and hail) for each of the 4 states of the northwest. The updated information in Section 3 is not categorized by the type of event, but the events are listed by state in chronological order.

28118 (IKE–8-20) **A region-based model for energy management planning in developing countries.** Saboohi, Y. Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme. Oct 1989. 184p. (In German). Order Number DE90773533. Available from NTIS (US Sales Only), PC A09/MF A01.

A thorough analysis of energy systems in developing countries necessitates a further improvement of the energy models. The energy models should be so developed that by means of these models an analysis of the specific issues of energy systems in developing countries would be possible. In the present study the energy demand model MADE (Model for Analysis of Demand for Energy) has been developed and the energy supply model MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental impact) has been regionalised. By means of model MADE it is possible to analyse the future development of energy demand in different sectors of the economy and to study energy requirement of urban and rural households. In addition, the impact of income distribution on the energy demand could be analysed. The regionalised energy supply model can be applied in analysing the regional aspects of energy systems and their impact on location of energy technologies. This model lends itself to an investigation of integrated multi-regional energy systems. The energy demand model MADE and the regionalised energy supply model were then applied in analysing the regional development of energy demand and supply in Iran. (orig.).

28119 (IKE–8-21) **Determination of flexible decision elements in long-term strategy planning in the energy industry.** Gerking, H. Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme. Nov 1989. 167p. (In German). Order Number DE90780121. Available from NTIS (US Sales Only), PC A08/MF A01.

Due to the increasing uncertainty and complexity in energy economics, planning became more and more important. This was taken into account by the application of mathematical models. Nevertheless, none of these models considers those uncertainties, which can only be reduced over time, the dynamic uncertainties. This report investigates this aspect and proposes a procedure how to define 'flexible decisions'. These decisions have to be made nowadays, but help avoiding a future crash of the system when unpredicted shocks occur. The introduction is followed by the

description of planning under existing uncertainties in energy economics. Subsequently methods for the handling of complex and long-term decisions under uncertainty are discussed and compared. Therefrom the necessity of the consideration of flexibility as goal of planning as a provision against dynamic uncertainties is derived. A case study demonstrates the procedure. Finally possibilities are shown how to quantify these 'flexible decision elements'. (orig.).

28120 (ORNL/TM–11441) **Energy efficiency: How far can we go?** Carlsmith, R.S. (Oak Ridge National Lab., TN (USA)); Chandler, W.U.; McMahon, J.E.; Santini, D.J. Oak Ridge National Lab., TN (USA). Jan 1990. 75p. Sponsored by U.S. DOE Office of Policy, Planning and Analysis. Order Number DE90010218. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The United States has made remarkable progress in efficient energy use since the 1973 oil crisis. In 15 years energy use increased only 8%, while gross national product increased 46%. Thus we are now using 26% less energy to produce one dollar's worth of goods and services. Some of this reduction came from structural changes in the economy, but most of it resulted from increases in energy efficiency. The experience shows that threats of shortages, rising prices, and government policies can make major changes in the operation of the economy. The questions we now face are the extent to which these trends in energy efficiency are likely to continue, and the factors that will influence them. On the one hand, overall energy efficiency has hardly changed since oil prices dropped precipitously in 1986. On the other hand, detailed studies of energy technologies all point to large opportunities for more efficient energy use, even at current fuel prices. Furthermore, it is frequently noted that other industrialized nations (with generally higher energy prices) use energy more efficiently than the United States. A review of these questions was undertaken by the staffs of five national laboratories during the summer of 1989. We undertook the review at the request of the Office of Policy, Planning and Analysis in the Department of Energy. Our purpose was to provide background information needed by the Department in formulating a new national energy strategy. A ground rule of the review was that changes in government policy were not to be considered, since later phases of the national energy strategy process will examine these issues. 110 refs., 28 tabs.

28121 (RISO-M–2809) **The DESS model: A detailed energy system simulation model for the EC countries.** Grohnheit, P.E. Risoe National Lab., Roskilde (Denmark). Systems Analysis. Oct 1989. 37p. Contract EN3M-0022-DK(B). Order Number DE90770670. Available from NTIS (US Sales Only), PC A03/MF A01.

The DESS (Detailed Energy System Simulation) Model is a tool for translating energy demand forecasts into their economic and environmental consequences. This model, which has been used for the Danish national energy planning, was developed and extended within the energy modelling program of the Commission of the European Communities into one that is able to simulate different national energy supply systems, in particular the power generating and space heating sectors. The model has now been implemented for Denmark, Germany, and Italy. The model implementation is described in this report, and further applications of the model is discussed. These include: national or multinational database and a simulation model for the energy system, database and preprocessor for optimisation models, and sectoral models, in particular for the power system with combined heat and power (CHP). Finally, the use of simulation models and optimisation models, e.g. the Energy Flow Optimisation (EFOM) model, is discussed. (author) 8 tabs., 6 ills., 39 refs.

28122 (SERI/TP–260-3674) **The potential of renewable energy: An interlaboratory white paper.** Solar Energy Research Inst., Golden, CO (USA); Idaho National Engineering Lab., Idaho Falls, ID (USA); Los Alamos National Lab., NM (USA); Oak Ridge National Lab., TN (USA); Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 194p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093;AC07-76ID01570;W-7405-ENG-36;AC05-8 Order Number DE90000322. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

On June 27 and 28, 1989, the US Department of Energy (DOE) national laboratories were convened to discuss plans for the development of a National Energy Strategy (NES) and, in particular, the analytic needs in support of NES that could be addressed by the laboratories. As a result of that meeting, interlaboratory teams were formed to produce analytic white papers on key topics, and a lead laboratory was designated for each core laboratory team. The broad-ranging renewables assignment is summarized by the following issue statement from the Office of Policy, Planning and Analysis: to what extent can renewable energy technologies contribute to diversifying sources of energy supply? What are the major barriers to greater renewable energy use and what is the potential timing of widespread commercialization for various categories of applications? This report presents the results of the intensive activity initiated by the June 1989 meeting to produce a white paper on renewable energy. Scores of scientists, analysts, and engineers in the five core laboratories gave generously of their time over the past eight months to produce this document. Their generous, constructive efforts are hereby gratefully acknowledged. 126 refs., 44 figs., 32 tabs.

2902 Economics and Sociology

Refer also to citation(s) 28120, 28176, 28179, 28187, 28188, 28195, 28348

28123 (DOE/CE/27472–T1) **The Northern Illinois Alliance to Support Least-cost Utility Planning: Final report, September 1987–September 1989.** Collins, N.E.; Jimenez, N.M. Chicago Dept. of Planning, IL (USA). Oct 1989. 677p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-87CE27472. Order Number DE90009410. Available from NTIS, PC A99/MF A01 - OSTI; GPO Dep.

The Northern Illinois Alliance to Support Least-cost Utility Planning (which came to be known as "The Alliance") was a pilot project devised for the purpose of determining the extent which an independent organization functioning outside the normal regulatory process could affect the emerging least-cost utility planning (LCUP) process in the State of Illinois. As with any social science experiment, much was learned; even aspects of the experiment that were not successful are of value. The emphasis in this report is on achievements and accomplishments of the Alliance, while acknowledging those tasks which were not completed and identifying barriers to LCUP in northern Illinois. The Alliance addressed two primary barriers to LCUP in northern Illinois — the lack of a cooperative planning forum and a common set of informational resources — by pursuing three goals: (1) assess the appropriateness to Northern Illinois of the energy technologies that are expected to be in the marketplace in the next two decades; (2) develop a process, including a forum for open discussion, to use the information presented during these discussions (and all other related information) in seeking consensus on the direction and contents of LCUP in the region; and (3) advance that process through technology transfer programs and disseminate information gained from the Alliance experience. A catalyst for the formation of the Alliance was the availability of grant funds from the US Department of Energy (DOE). The proposal submitted to and subsequently funded by DOE's Office of Buildings and Community Systems (OBCS) included an array of activities, research tasks, and organizational objectives to be undertaken by the Alliance.

28124 (ISTC-PU–3040) **Fluids-handling and mechanical power-transmission equipment.** Industry profile. Industry, Science and Technology Canada, Ottawa, ON (Canada). 1988. 18p. (MICROLOG–90-00498). Available from PC Canada Dept. of Regional Industrial Expansion, Library (CEIB), 235 Queen St., Ottawa, ON, CAN K1A 0H5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This industry profile assesses, in a summary form, the current competitiveness Canada's fluids handling and mechanical power-transmission equipment industry, taking into account technology and other key factors, and the changes anticipated with the Canada-USA Free Trade Agreement. This sector comprises about

180 manufacturers located primarily in Ontario, Quebec and Western Canada, employing an estimated 9250 persons. There is a world-wide over-capacity in this industry This situation has led to increased levels of rationalization of production, and also to more intense competition in both domestic and international markets. Canadian manufacturers are currently operating at about 50% capacity. The fluids-handling and mechanical power-transmission subsectors are described as to imports, exports, market, economic performance, and competitiveness with respect to the structural, trade-related, technological and other factors. The Canadian-owned manufacturers which produce niche-market products, as well as the companies operating assembly warehouse-sales facilities, are not expected to experience significant difficulties as a result of free trade with the USA. However, the manufacturers of more standard products in which productivity is related to economies of scale may lose manufacturing capability while retaining their current warehousing, sales and service facilities. 2 figs., 4 tabs.

28125 (PNL–6880) **Energy's role in competitiveness: Context and strategy.** Roop, J.M. Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 67p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-76RL01830. Order Number DE90009519. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This study of competitiveness has three objectives. The first objective is to explain how macroeconomic and microeconomic factors can affect structural change in the US economy and how energy is linked to these factors. The second objective is to provide an explanation of how many individual decision makers, in responding to higher energy prices, have changed the structure of the economy. This structural change, and the effect it has had on energy use, is estimated for the US economy. A major component of these changes results from changes in US trade with other countries, which gives rise to the third objective. The third objective is to develop a research design that will allow a better understanding of the role that energy plays in the competitiveness of goods in world trade. 30 refs., 11 figs., 5 tabs.

28126 (SEG–CE02905) **The ninth annual energy pricing conference: Analyzing Canadian prices and markets.** Southam Energy Group, Toronto, ON (Canada). 1989. vp. (CONF-891075–: 2. international conference on engineering management, Toronto (Canada), 16-18 Oct 1989; CE–02905). Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

This conference includes industry and analyst perspectives for natural gas, refined products, interfuel competition, and crude oil. Papers were also presented on economic impacts on energy prices in general and on coal and uranium; the environmental impact on energy prices; and government perspectives. Separate abstracts have been prepared for for 18 papers.

2903 Environment, Health, and Safety

Refer also to citation(s) 27463, 27464, 27567, 27569, 27570, 27571, 27574, 27704, 27945, 28011, 28173, 28195, 28252, 28275, 28276, 28288, 28312, 28320, 28321, 28322, 28323, 28324, 28325, 28326, 28327, 28328, 28329, 28330, 28356, 28357, 29000, 29003, 29005, 29012, 29013, 29015, 29031, 29032, 29034, 29035, 29051, 29056, 29059, 29072, 29082, 29083, 29086, 29089, 29090, 29091, 29092, 29093, 29094, 29095, 29098, 29234

28127 (PB–90-107491/XAB) **National Sewage-Sludge Survey facility analytical results. Volume 1-4.** Environmental Protection Agency, Washington, DC (USA). Office of the Assistant Administrator for Water. Oct 1989. 3565p. Available from NTIS, PC EE99/MF E99.

The National Sewage Sludge Survey (NSSS) is a questionnaire and analytical survey of Publicly Owned Treatment Works (POTWs) intended to produce national estimates of: (1) Concentrations of toxic contaminants in municipal sludge; (2) Sludge generation and treatment processes; (3) Sludge use and disposal practices and alternative use and disposal practices; and (4) Treatment and disposal costs. The survey will provide reliable, current data that can be used in the regulatory impact analysis (RIA) and aggregate risk analysis (ARA) to project impacts and benefits to support promulgation of the first round technical regulation for sewage sludge pollutants and use and disposal practices (40 CFR Part 503).

28128 (PB–90-107509/XAB) **Data-element dictionary 1988 sewage-sludge use and disposal: Questionnaire data base.** Environmental Protection Agency, Washington, DC (USA). Office of the Assistant Administrator for Water. Oct 1989. 1460p. Available from NTIS, PC EE99/MF E14.

The National Sewage Sludge Survey (NSSS) is a questionnaire and analytical survey of Publicly Owned Treatment Works (POTWs) intended to produce national estimates of: (1) Concentrations of toxic contaminants in municipal sludge; (2) Sludge generation and treatment processes; (3) Sludge use and disposal practices and alternative use and disposal practices; and (4) Treatment and disposal costs. The survey will provide reliable, current data that can be used in the regulatory impact analysis (RIA) and aggregate risk analysis (ARA) to project impacts and benefits to support promulgation of the first round technical regulation for sewage sludge pollutants and use and disposal practices (40 CFR Part 503).

28129 (PB–90-155581/XAB) **Risk-assessment guidance for Superfund. Volume 1. Human Health Evaluation Manual. Part A. Interim report (Final).** Means, B. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste and Emergency Response. Dec 1989. 290p. (EPA–540/1-89/002). Available from NTIS, PC A13/MF A02.

See also Volume 2, PB–90-155599.

The document is part of a two-manual set entitled Risk Assessment Guidance for Superfund. One manual, the Environmental Evaluation Manual, provides guidance for ecological assessment at Superfund sites; the other, the Human Health Evaluation Manual, provides guidance for health risk assessment of these sites. The Risk Assessment Guidance for Superfund manuals were developed to be used during the Removal and Remedial Investigation/Feasibility Study (RI/FS) processes at Superfund sites. The analytical framework and specific methods described in the manuals, however, may also be applicable to evaluations of hazardous wastes and hazardous materials for other purposes. The two manuals in the set have somewhat different target audiences. The Environmental Evaluation Manual primarily addresses Remedial Project Managers (RPMs and On-Scene Coordinators (OSCs)), who are responsible for ensuring a thorough evaluation of potential environmental effects at sites. The Human Health Evaluation Manual provides for the risk assessor - Updated procedures and policies, specific equations and variable values for estimating exposure, and a hierarchy of toxicity data sources.

28130 (PB–90-155599/XAB) **Risk-assessment guidance for Superfund. Volume 2. Environmental evaluation manual. Interim report (Final).** Mundy, P.; Bascietto, J. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste and Emergency Response. Mar 1989. 63p. (EPA–540/1-89/001). Available from NTIS, PC A04/MF A01.

See also Volume 1, PB–90-155581.

The document is part of a two-manual set entitled Risk Assessment Guidance for Superfund. One manual, the Environmental Evaluation Manual, provides guidance for ecological assessment at Superfund sites; the other, the Human Health Evaluation Manual, provides guidance for health risk assessment of these sites. The Risk Assessment Guidance for Superfund manuals were developed to be used during the Removal and Remedial investigation/Feasibility Study (RI/FS) processes at Superfund sites. The analytical framework and specific methods described in the manuals, however, may also be applicable to evaluations of hazardous wastes and hazardous materials for other purposes. The two manuals in the set have somewhat different target audiences. The Environmental Evaluation Manual primarily addresses Remedial Project Managers (RPMs) and On-Scene Coordinators (OSCs), who are responsible for ensuring a thorough evaluation of potential environmental effects at sites. The Environmental Evaluation Manual is not a detailed how-to type of guidance, and it does not provide cookbook approaches for evaluation.

28131 (PB–90-159534/XAB) **Partnerships under pressure. Managing commercial low-level radioactive waste.** Gibbons,

J.H. Office of Technology Assessment (U.S. Congress), Washington, DC (USA). Nov 1989. 159p. (OTA-O–426). Available from NTIS, PC A08/MF A01.

Also available from Supt. of Docs.; Library of Congress catalog card No. 89-600772.

The report provides an overview of progress made by nine compacts and the remaining unaffiliated States in developing disposal facilities. Disposal costs have more than tripled while LLW volumes have dropped by more than half over the last decade. Since many costs associated with developing and operating a disposal facility are fixed, unit disposal costs will increase substantially as new facilities open, leading States to consider the economics of cooperative arrangements, which would permit them to trade waste services and construct fewer full-service disposal facilities. A small percent of LLW is labeled mixed LLW because it also contains components classified as hazardous under the Resource Conservation and Recovery Act. Jurisdiction over mixed LLW disposal falls jointly to the Nuclear Regulatory Commission and the Environmental Protection Agency. Unfortunately, some regulations aimed at mixed LLW are unattainable, inconsistent, or duplicative. Unless current regulations are revised, generators of mixed LLW (e.g., industries, hospitals, nuclear power plants, and laboratories) are left with three options: stop producing the waste (which can mean going out of business), illegally store the waste or illegally dispose of the waste. The report presents options on how the dilemma may be addressed.

28132 (PB–90-168584/XAB) **NIOSH (National Institute for Occupational Safety and Health) projects for FY 1989.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). May 1989. 145p. (DHHS/PUB/NIOSH–89-112). Available from NTIS, PC A07/MF A01.

The projects described in the document reflect the direction provided by the National Strategies for the Prevention of the Ten Leading Work-Related Diseases and Injuries. In addition to orienting the National Institute for Occupational Safety and Health (NIOSH) research program to address these leading work-related diseases and injuries, the occupational safety and health community is paying increasing attention to the National Prevention Strategies. NIOSH serves the nation as the federal scientific leader in the occupational safety and health community. The scientific expertise of the Institute is highly regarded both nationally and internationally. The scientifically based policy documents and reports of the investigations identifying hazards and detailing means of controlling them to prevent disease and injury serve as standard references. Contents of the report include: NIOSH planning format; Organization chart; Divisions mission statements; Summaries of NIOSH strategies; Projects by program areas; and Projects by division.

28133 (PNL–7292) **Regulatory standards applicable or relevant to the independent Hanford environmental surveillance and oversight program.** King, S.E. (Pacific Northwest Lab., Richland, WA (USA)); Hendrickson, P.L.; Siegel, M.R.; Woodruff, M.G.; Belfiglio, J.; Elliott, R.W. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 72p. Sponsored by U.S. DOE Environment Health & Safety. DOE Contract AC06-76RL01830. Order Number DE90009392. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

The authors reviewed federal and state statutes and regulations, as well as Department of Energy (DOE) orders and other guidance material, for potential applicability to the environmental surveillance program conducted for the Hanford site by the Pacific Northwest Laboratory (PNL). There are no federal or state statutes or regulations which are directly applicable to the environmental surveillance program. However, other regulatory schemes, while not directly applicable to the environmental surveillance program, are important insofar as they are indicative of regulatory concern and direction. Because of the evolving nature of environmental regulations, this area needs to be closely monitored for future impact on environmental surveillance activities. 9 refs.,

28134 (SSI–89-02) **How risky is energy production in Sweden and why is it accepted.** Bengtsson, G. National Inst. of Radiation Protection, Stockholm (Sweden). 3 Feb 1989. 29p. Order Number DE90770800. Available from NTIS (US Sales Only), PC A03/MF A01.

From Swedish energy studies during the last decade some fundamental suggestions for the management of environmental and health risks have emerged, the most important of which is that the flow of pollutants in the environment should not be large in comparison with the natural flows. This paper shows that this rule can be followed within a few decades. Energy demand can be reduced by conservation without jeopardising a good economy. In combination with more intense use of renewable energy sources, this is the road proposed by Swedish politicians to enable the phasing out of nuclear power by the year 2010. This road must be promoted by government actions if Swedish energy production is to be in balance with nature within the next generation. (orig.).

28135 (VTT-SYMP–103, pp. 9-22) **Cleaner technologies through process modifications and material substitutions.** Huisingh, D. (TEM/University of Lund, Sjoebo (Sweden)). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

In general, the approach being used is to seek ways to modify manufacturing processes by raw material substitutions or process modifications so as to produce present-day products more safely and with less waste. In other situations, product designers are beginning to design new products with Nature in Mind. In doing this they are seeking to develop and utilize product design criteria that incorporate consideration of life cycle impacts into the product's design. The design criteria are selected to reduce wastes and to minimize toxic risks in: The production of the raw materials for the new products, the production of the new products, the consumer's use of the new products and finally the end disposition of the new products. This paper addresses both categories of approaches and additionally emphasizes the importance for all industrial leaders, governmental authorities and educational agents to be actively engaged in fostering the development and utilization of such approaches in such a way that environmental ethics plays an increasingly significant and integral role in their everyday decisions. In so doing they will be moving beyond the basic sstance typical of many industrialists in the past, namely, to resist regulators' efforts to press for environmental quality improvements. Industrialists, in companies in many countries are leading the way to the new vision.

28136 (VTT-SYMP–103, pp. 99-112) **Waste treatment and waste minimization programs in the USA.** Skinner, J.H. (U.S. Environmental Protection Agency Washington, D.C. (USA). Office of Environmental Engineering and Technology Demonstration). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

It is the national policy of the United States that, whenever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. In general, hazardous waste treatment or resource recovery techniques which permanently and significantly reduce the volume, toxicity, or mobility of hazardous constituents are preferred over techniques not in volving such treatment. These policies have envolved out of a concern about the long-term potential for release of hazardous substances from landfills and other facilities that are used to dispose of hazardous wastes on or into the land. A comprehensive Federal program or research, development, demonstration and training has been established to promote the development and use of innovative hazardous waste treatment technologies. One focus of this program is on technologies that permanently alter the composition of hazardous wastes through chemical, biological, thermal or physical means. Another focus is on approaches to reduce the generation of waste at the source. This can be done through modification of production processes and end products, reduction or substitution of raw materials and implant recycling and reuse. Activities under this program include cooperative efforts with private industry to cooperative efforts with private industry to develope innovative waste treatment and minimization techniques, demonstration of promising

techniques to develop performance and cost information, and technology transfer, training and technical assistance.

28137 (VTT-SYMP–103, pp. 23-34) **Development of low- and non-waste technological processes and production.** Zaitsev, V.A. (Mendeleev Institute of Chemical Technology, Moscow (USSR)). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

The concept of non-waste technology includes not only the technological processes but a set of organizational, technical and administrative measures, research and development work. Considering the numerous forms of promoting development and implementation of non-waste technology and production developed and used in various countries, the quantitative criteria of non-waste level of enterprises and their classification as non-waste, low-waste or conventional are of utmost importance. The coefficient of non-waste production suggested in the chemical industry of USSR is of most interest. This coefficient characterizes the competence of material and energy resources utilization in production and the intensity of the impact of the production on the environment. USSR has already gained some experience in developing low- and non-waste technological processes and production, regional and national programs that ensures the solution of the whole complex of ecological problems.

28138 (VTT-SYMP–103, pp. 43-50) **Outlook and ways of implementation of clean technologies in the Italian chemical industry.** Guidotti, G.R. (ENEA - Italian Commission for Nuclear and Alternative Energies, Rome (Italy)); Castagnola, A.M. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

On behalf of the Italian Government an Experts' Task Force has been recently appointed: (a) to assess the curent state of clean (non-waste) technologies in various industrial sectors including chemical industry, food industry, metallurgy, energy production, transport, waste treatment and recycling, etc.; (b) to suggest means for implementing process technologies as substitutes for downstream technologies in order to reduce production wastes. Here briefly discussed are the outcome of an inquiry held on a national scale into up-dated perspectives and means of implementing cleaner technologies compared to those currently used in the Italian chemical industry. The industrial sectors have been examined by the case study approach methodology on the grounds of criteria of waste production, resource use, economic relevance and industrial propensity to change. The strategy guidelines felt to better encourage the application of cleaner chemical processes in the framework of an industrial policy in Italy are suggested. Legislative, financial and organizational means to speed up, when ever possible, the introduction of implemented or innovative technologies allowing process wastes to be markedly reduced are discussed.

28139 (VTT-SYMP–103, pp. 137-150) **America's future in toxic waste management. Lessons from Europe.** Davis, G.A. (University of Tennessee, Knoxville (USA). Waste Management Research and Education Institute); Piasecki, B.W. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

America now stands ready to dramitically redirect its hazardous waste management practices away from long-standing reliance upon land disposal. A new focus on waste reduction is taking hold, and a new generation of recycling and treatment technologies is being placed into the market as land disposal is restricted. In deciding to restrict land disposal American policymakers looked to Western Europe for the basic lesson that waste reduction measures and practical recycling and treatment technologies exist that eliminate the need for land disposal of untreated waste. The authors of this paper spent two years researching Western European hazardous waste policies to determine further lessons that can be learned to help guide America's future in hazardous waste management. The resulting book, America's Future in Toxic Waste Management: Lessons from Europe (Greenwood Press 1987) and this paper summarize policy lessons from Western Europe that can be applied to expedite America's shift away from land disposal and report on uniquely American adaptations of European models that are already emerging.

28140 (VTT-SYMP–103, pp. 129-134) **A common nordic strategy on waste management - illusion or reality?** Hirsbak, S. (Technological Institute, Copenhagen (Denmark). Center of Cleaner Technologies). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

The Nordic Council of Ministers adopted a recommendation on recycling of waste and reduction of the consumption of natural resources in 1978. The rate of recycling in the Nordic Countries is increasing, but the volumes of wastes have increased even more. Also the quantitites of harmful waste have increased. Waste incineration contributes to the pollution of the environment due to releases of e.g. heavy metals and dioxins. Since 1978 the Nordic working group on waste and recycling has been engaged in acitivities to initiate Nordic cooperation in this field. In order to further strengthen the cooperation the group has found it necessary to establish a basis or strategy for a long-term action plan. The primary aim of the strategy should be to protect the environment against pollution and next to reduce the waste volumes and the consumption of virgin raw materials and energy. Following three methods should be used in combination with each other. Prevention of waste generation, by using less environmentally harmful and waste reducing technologies, increased recycling of products, materials and energy, and the minimization of emissions to the air, water and soil, and protection of the working environment by better handling/processing of waste. In the Nordic countries the most important tools have so far been: total or partial State monopoly of waste handling, environmental approvals of waste treatment facilities, like incineration plants and landfill sites, and in particular, plants for treatment of environmentally harmfull waste and State subsidies to recycling plants and development of new waste treatment techniques.

28141 (VTT-SYMP–103, pp. 315-321) **Towards a network for environmental technology transfer.** Haines, R.C. (ECOTEC Research and Consulting Ltd, Birmingham (UK)). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-wate technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

This short paper presents information on current thinking with regard to a proposed Network for Environmental Technology Transfer. This initiative in being promoted by the Commission of the European Communities within the framework of European Year of the Environment. ECOTEC Research and Consulting Ltd have been involved with the feasibilty and specification work and are currently acting fot the CEC to examine the most appropriate mechanisms for its implementation.

28142 (VTT-SYMP–103, pp. 323-332) **International cooperation status and demands for the future.** Mueller, K. (National Agency of Environmental Protection, Copenhagen (Denmark)). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

On the backround of the results of the conference, the status of the international cooperation is analyzed by using the national and international activities in the field of cleaner technologies. The analysis leads to need for cooperation in a number of points. The conclusion is that only an independent organization will be able to solve the demands of the future. It is the author's expectation and

hope that the International Association for Cleaner Technology will be the right forum.

28143 (WSRC-MS-90-07) **A planning process for an improved environment at the Savannah River Site.** Hutchison, J.B. (Westinghouse Savannah River Co., Aiken, SC (USA)); Jernigan, G.F.; Whitfield, K. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-900210--41: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90009141. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The environmental planning process at the Savannah River Site is described. A process has evolved over the last several years to address the prevention of environmental problems and improve compliance for all environmental media. The plan addresses existing site conditions, objectives, strategies, implementation methods, and resource requirements for specific environmental media (surface water, groundwater, drinking water, land use, waste, air, etc.) and support activities (auditing, compliance tracking, employee education, community awareness, etc.). The plan has been utilized for the preparation of several other documents and reports. A comprehensive site database was developed and has been utilized for the preparation of several documents and reports. The purpose of this paper is to describe how one of the Department of Energy (DOE) nuclear materials production facilities, the Savannah River Site (SRS), has moved toward the use of an overall planning process to develop programs and attain/maintain compliance with environmental requirements including waste management and environmental restoration. The goal is not just meeting a requirement of developing a five-year plan for waste management and environmental restoration, but using a planning process to address prevention of problems and improve compliance for all environmental media. 6 figs.

28144 The effects of uncertainty on the analysis of atmospheric deposition. Volume 6. Bloyd, C.N. (Argonne National Lab., Argonne, IL (US)); Small, M.J.; Henrion, M.; Rubin, E.S. 16p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679--: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

Technical Paper 88-104.3.

Research efforts on the problem of acid ran are directed at improving current scientific understanding in critical areas, including sources of precursor emissions, the transport and transformation of pollutants in the atmosphere, the deposition of acidic species, and the chemical and biological effects of acid deposition on aquatic systems, materials, forests, crops and human health. The general goal of these research efforts is to characterize the current situation and to develop analytical models which can be used to predict the response of various systems to changes in critical parameters. This paper describes a framework which enables one to characterize uncertainty at each major stage of the modeling process. Following a general presentation of the modeling framework, a description is given of the methods chosen to characterize uncertainty for each major step. Analysis is then performed to illustrate the effects of uncertainty on future lake acidification in the Adirondacks Park area of upstate New York.

28145 The NPDES program in West Virginia: Getting back to the basics. Politon, K. (West Virginia Dept. of Energy, Charleston (USA)). pp. 244 of Proceedings of the ninth annual West Virginia Surface Mine Drainage Task Force symposium. West Virginia Surface Mine Drainage Task Force, Morgantown, WV (US) (1989). (CONF-8904305--: 9. annual West Virginia surface mine drainage task force, Morgantown, WV (USA), 25-26 Apr 1989).

This paper discusses the history of the National Pollutant Discharge Elimination System (NPDES) regulation and enforcement in West Virginia. The NPDES was developed out of the Clean Water Act and regulates the water quality discharges from point source pollutants for waste water. This paper goes on to discuss the need for water quality standards in the NPDES program along with the need for accurate definitions of these standards.

28146 Detection and imaging of buried wastes using seismic wave propagation. King, W.C. (Field Support Agency, U.S. Army Envir. Hygiene Activity-West, Aurora, CO (US)); Witten, A.J.; Reed, G.D. *Journal of Environmental Engineering (New York) (USA)*, 115(3): 527-540 (Jun 1989).

This paper reports on a geophysical tool for high resolution subsurface imaging which has numerous applications in the field of hazardous waste management. The primary steps of the technique are: an acoustic wave is projected through a subsurface cross section to a hydrophone array located vertically in a borehole; the amplitude versus time signal of the propagating wave is collected at each hydrophone; and the reduced wave equation and theory of backpropagation tomography are invoked to reconstruct the subsurface features from the collected data. The development of this emerging technology is highlighted beginning with its theoretical conception, through system development and field testing, to an examination of its future applications in environmental engineering.

2904 Energy Resources

Refer also to citation(s) 28126, 28183, 28287

28147 (CERI-89-05379, pp. 101-120) **Exploration and development prospects in the Pacific Rim.** Boyce, M.W. (Chevron Overseas Petroleum Inc., San Ramon, CA (USA)). Canadian Energy Research Inst., Calgary, AB (Canada). 1986. (CONF-8609481--: International oil and gas markets conference, Calgary (Canada), 15-16 Sep 1986; MICROLOG-89-05379). In *Papers presented at the International oil and gas markets conference*. Available from PC Canadian Energy Research Institute, 3512-33rd St. NW, Calgary, AB, CAN T2L 2A6; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC $100.00 CAN; MF $10 CAN.

This paper presents the highlights of Pacific Rim oil and gas discoveries. Sites discussed include North Slope Alaskan Oil, the North China Basin, the East China sea, and the central region of the Western Pacific. More gas than the region's domestic markets can presently absorb has been discovered and these resources will not be developed until the market improves. The depressed-price environment facing the petroleum industry, has had a profound impact on exploration and development worldwide. Even projects with favorable economics are being curtailed because of cash flow restrictions facing both industry and participating national governments. The only major projects now being initiated are those that have been strongly encouraged by governments. On the exploration side, there is a reduced, but still sizeable effort to find large oil reserves worldwide. The Pacific Rim areas face significant production declines in the early 1900's, and hopefully also an oil price rebound to more acceptable levels. To meet this future demand, the oil industry must continue to actively explore those basins that have large reserve potential. Emphasis will be on areas with low costs, close to markets or export facilities, and attractive government fiscal terms that provide the required economic return. For the next few years the industry's scarce exploration funds, and even scarcer development funds, will be channeled preferentially to those areas where governments provide the most attractive economic incentives.

28148 (PB-90-167453/XAB) **Natural resources and users benefit from the Conservation Reserve Program.** Ribaudo, M.O.; Colacicco, D.; Langner, L.L.; Piper, S.; Schaible, G.D. Economic Research Service, Washington, DC (USA). Resources and Technology Div. Jan 1990. 54p. (USDA/AER-627). Available from NTIS, PC A04/MF A01.

Also available from Supt. of Docs.

The Conservation Reserve Program (CRP) may generate $6-14 billion (present value) in benefits to natural resources if 45 million acres of highly erodible or environmentally sensitive cropland are removed from agricultural production by 1990. Protecting the soil by retiring and planting permanent grasses and trees on such land for 10 years will improve soil productivity, water quality, air quality, wildlife habitat, and groundwater supply. But the magnitude and distribution of benefits can be altered by changing the emphasis of the program. The report estimates how retiring cropland benefits natural resources under three scenarios of CRP enrollment.

2905 Research, Development, Demonstration, and Commercialization

Refer also to citation(s) 27391, 27392, 27393, 27394, 27395, 27396, 27397, 27398, 27399, 27404, 27421, 27535, 27647, 27648, 27895, 28023, 28123, 28125, 28207

28149 (BP–587-0390-2M-T) **Idaho National Engineering Laboratory annual report.** White, J. EG and G Idaho, Inc., Idaho Falls, ID (USA). 1989. 58p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009767. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This Idaho National Engineering Laboratory annual report discusses the operations and accomplishments for 1989. Topics include computer science, reactor technology, research and analysis, instrumentation and controls, waste management, facilities, cooperative studies, and new projects and capabilities. 37 figs. (KD)

28150 (NEI-FI–93) **Collaboration on Energy Research between the United States and Finland.** Vainio, P.L. (Helsinki Univ. of Technology, Otaniemi (Finland)). Kauppa- ja Teollisuusministerio, Helsinki (Finland). Energiaosasto. 1989. 41p. Project KTM-63/429/89. (CONF-8910385–1: US-Finnish meeting on science and technology, Helsinki (Finland), 23-26 Oct 1989). Order Number DE90770720. Available from NTIS (US Sales Only), PC A03/MF A01.

The report describes the background of the energy research collaboration between the US and Finland. New fields for cooperation are presented. Three of them are introduced in more detail: combustion and environment technology, energy technologies in buildings and new energy technologies. Some projects from each field are proposed for new collaboration.

28151 (ORNL/FMP–89/2, pp. 607-608) **BCL-4 - Materials and components in fossil energy applications newsletter.** Wright, I.G. (Battelle, Columbus, OH (USA)). Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The DOE Newsletter on Materials and Components in Fossil Energy Applications is intended as a vehicle to provide timely dissemination of information concerning developments in, or performance results of, materials and components in conventional or new processes for the utilization of coal, or for the conversion of coal to other energy forms. The role of the newsletter has been to provide a guide to developing materials and components technology, and a forum for the presentation of the latest results and experience.

28152 (ORNL/FMP–89/2, pp. 609) **NIST-4 - An assessment of fossil energy materials research needs.** Dapkunas, S.J. (National Institute of Standards and Technology, Gaithersburg, MD (USA)); Sorrell, G. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

Efforts to date have been directed toward review of prior assessments of fossil energy systems research needs as well as discussions with industrial personnel to identify research areas with high potential payoff in terms of plant durability and cost as well as process efficiencies. Areas of focus include alloy development, separation and filtration systems, solid electrolyte and catalysts.

28153 (ORNL/FMP–89/2, pp. 611) **ORNL-4(B) - Coal conversion and utilization plant support services.** Keiser, J.R. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

In support of an effort to explain the high rate of metal wastage of tubes in the TVA 20 MWe atmospheric fluidized bed combustor (AFBC), mechanical properties microprobe (MPM) studies were made on ash, rock, and coal samples from several different feed coals used in the AFBC. These studies were conducted because of a concern that a very thin layer with hardness different from the base material might be contributing to the unexpectedly high wastage rates. The MPM is able to make hardness indentations a few micrometers apart so that shell with hardness different from the base material could be detected. Results of these measurements are currently being evaluated.

28154 (PJM–CE02952, pp. 92-95, Paper 17) **Bioenergy: Potential and opportunities.** Pneumaticos, S. (Energy, Mines and Resouces Canada, Ottawa, ON (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

Canada is a net importer of oil. It has established a policy objective to decrease dependance on imported oil. Biomass makes an attractive alternative to oil because it is a renewable resource, it is widely distributed throughout the country, and biomass conversion processes are benign relative to those involving coal. Its disadvantages are that is a low energy density, high bulk material which contains a great deal of water which must be removed. Energy from mill residue biomass can be produced at a cost of $4.00 to $8.00 per GJ. This compares to a cost of $6.50 to $7.00 per GJ for oil and $6.00 for natural gas. The economics of gasification of biomass or conversion to liquid fuels for transportation does not seem promising at today's fossil fuel prices. The Canadian government has several programs in place to promote the use of biomass fuels. These include the Forest Industries Renewable Energy program (FIRE) which provides financial incentives for the use of biomass fuels in industries; the Canadian Oil Substitution Program which provides incentives for the conversion of residentail heating systems to natural gas, solar heating or biomass based system; Canertech which invests in ventures to promote conservation and use of renewable energy, the Energy from Forests (ENFOR) program, and the New Liquid Fuels project, a biomass fuels R&D program.

28155 (PJM–CE02952, pp. 11-1 Paper 3) **Forest industry energy retrospectives.** Evans, R.S. (FORINTEK Canada, Vancouver, BC (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report describes the evolution of Canadian government biomass to energy support programs from 1977 to 1982. The Renewable Energy Branch of the Department of Energy, Mines and Resources was established in 1977 as a response to the oil prices increases and to the realization that western Canadian oil and gas reserves were limited. The Branch undertook as one of its first acts, an assessment of the energy potential of forest biomass in Canada. Three scales of usage of forest biomass were established. The forest products industry was, in 1977, the largest industrial consumer of petroleum products in Canada. For the near term (to 1983) the goal was to have the industry utilize existing opportunities for the sustitution of mill residues for fossil fuels. For the medium term (to 1990) the goals was to have industry utilize noncommercial trees and tree residues currently left in the forest. For the long term (to 2050) the goal was to investigate the possibilities to use the forests as the base for a large energy and synthetic chemical industry. From this beginning the ENFORE (Energy for Forests) program was formed. The FIRE (Forest Industry Renewable Energy Program) was established to supply funds to cover the capital costs of conversion. A Loan Guarantee program was cancelled in 1979. The FIRE program has make a total of 90 grants, 37 in Quebec and the Maritimes and 27 in B.C. Ten hog fuel systems are currently in place on mill sites as a result of FIRE funding.

28156 (PJM–CE02952, pp. 6-7, Paper 1) **FIRE [Forest Industry Renewable Energy] program, policy and background.** Strange, D. (Energy, Mines and Resources Canada, Ottawa, ON (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.*

Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper describes the Energy, Mines and Resources Canada's Forest Industry Renewable Energy (FIRE) program. The orginal FIRE program was introduced in 1978 as a part of a major initiative to promote conservation and renewable energy use in Canada. The intent of the program was to promote the use of biomass fuels by the forest industry. In 1980 the program was expanded to include public sector organizations and industries beyond the forest industry. In 1981 biomass made up 3.6% of Canada's fuel. The program goal was to double this by 1990. Beyond 1990 the goal was to maintain the new rate of use. As of June, 1982 the program supported 104 projects at a cost of $52,000,000. Most of these were in the pulp and paper industry. Since June, 1982 the program has resulted in an annual fossil fuel saving of 6,500,000 barrels of oil. The program has displaced oil, natural gas, coal, and to a lesser extent electrical energy use.

2906 Nuclear Energy

Refer also to citation(s) 27784, 27984, 27985, 28122, 28366

28157 (LBL-PUB–625-Vol.16) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 16, January 1, 1968–June 30, 1968.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 587p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 16 which covers January thru June 1968.

28158 (LBL-PUB–625-Vol.17) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 17, July 1, 1968–January 19, 1969.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 600p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 17 which covers July 1968 thru January 1969.

28159 (LBL-PUB–625-Vol.18) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 18, January 20, 1969–April 30, 1969.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 558p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 18 which covers January thru April 1969.

28160 (LBL-PUB–625-Vol.19) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 19, May 1, 1969–August 31, 1969.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 684p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 19 which covers May thru August 1969.

28161 (LBL-PUB–625-Vol.21) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 21, January 1, 1970–April 30, 1970.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 795p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 21 which covers January thru April 1970.

28162 (LBL-PUB–625-Vol.22) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 22, May 1, 1970–August 31, 1970.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 651p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 22 which covers May thru August 1970.

28163 (LBL-PUB–625-Vol.23) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 23, September 1, 1970–December 31, 1970.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 694p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 23 which covers September thru December 1970.

28164 (LBL-PUB–625-Vol.24) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 24, January 1, 1971–April 30, 1971.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 721p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 24 which covers January thru April 1971.

28165 (LBL-PUB–625-Vol.25) **Journal of Glenn T. Seaborg, Chairman of the US Atomic Energy Commission, 1961–1971: Volume 25, May 1, 1971–November 6, 1971.** Seaborg, G.T. Lawrence Berkeley Lab., CA (USA). c Jan 1989. 841p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. Available from Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720.

I include a historical summary of the major accomplishments of the Atomic Energy Commission during the period of my chairmanship. This is done in a topical manner, i.e., by describing in summary form the accomplishments in each of a selected number of subject areas over the ten-year period. This is Volume 25 which covers May thru November 1971.

28166 (PB–90-165101/XAB) **Physical Security Review Board. Directive.** Cavileer, D. Office of the Deputy Under Secretary of Defense for Policy, Washington, DC (USA). 10 Feb 1981. 6p. (DOD-D–5100.76). Available from NTIS, PC A02/MF A01.

The Directive reissues Department of Defense (DoD) Directive 5100.76, May 17, 1977, to continue, in restructured form, the Physical Security Review Board, and modify the reporting criteria previously set forth. It outlines the authorities, responsibilities, and functions relative to the formulation of world-wide uniform policy, standards, and procedures for the physical security of nuclear weapons, devices, reactors, and materials, and conventional arms, ammunition, and explosives in the possession or custody of DoD Components. The Directive also authorizes the issuance of DoD 5100.76-M.

2908 Heat Utilization

Refer also to citation(s) 27940

2910 Conservation

Refer also to citation(s) 28120, 28188, 28201, 28229, 28233, 28234, 28251, 28252, 28260, 28281, 28282

28167 (DOE/CH/10379–1) **ICP [Institutional Conservation Program] monitoring: Final report.** Carpenter Environmental Associates, Inc., Northvale, NJ (USA). Aug 1989. 66p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-88CH10379. Order Number DE90009482. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The following pages present the final report of activities undertaken by Carpenter Environmental Associates, Inc. (CEA) in carrying out its contractual obligations for the New York Support Office of the US Department of Energy. The contract calls for the field monitoring/review of DOE grants to schools and hospitals under the Institutional Conservation Program (ICP). This final report is the result of a review of statistics and findings gathered over the period of the contract, which included monitoring visits to 50 grantees in New York State and New Jersey. The report is intended to highlight aspects of the monitoring project and to make recommendations. This report is organized into four sections: Section 1 details the steps taken by CEA in organizing and implementing the review; Section 2 presents program statistics; Section 3 discusses monitoring review concerns, implementation issues and commonly observed problems/accomplishments; and Section 4 lists recommendations. Taken as a whole, this final report is intended to convey a complete picture of CEA's activities under this contract. 25 tabs.,

2920 Supply, Demand, and Forecasting

Refer also to citation(s) 27614, 28126, 28147, 28184, 28185, 28186, 28202, 28204, 28205, 29066

28168 (NEI-FI–90, pp. 7) **The energy supply in Finland in the 21st century.** Lepistoe, A. (Kauppa- ja Teollisuusministerio, Helsinki (Finland). Energiaosasto). Valtion Teknillinen Tutkimuskeskus, Jyvaeskylae (Finland). Kotimaisten Polttoaineiden Lab. 1989. (In Finnish). (CONF-8901185–: Seminar on Energy meeting in Middle-Finland '89: energy and society, Jyvaeskylae (Finland), 19 Jan 1989). In *Energy Meeting in Middle-Finland 89.* Order Number DE90706084. Available from NTIS (US Sales Only), PC A05/MF A01.

The author describes here the prospects of Finnish energy production and utilization in the future. The energy consumption as well as the fates and possibilitie in energy production are discussed in this presentation. Energy consumption in Finland will continue to increase in this century. At the maximum the consumption of electric power 60% higher. In the beginning of the next chiliad the increase will stop and it might even decrease. The majority of houses will be connected to district heating and the gasoline fueled automobiles would be used for transportation of people. The mechanical pulping methods would be commonly used and the households and services would use more electricity. The oil consumption would decrease and coal consumption in crease up to 10 million tons per year. The consumption of peat would be doubled and the consumption of natural gas tripled. The amount of industrial waste derived fuels would not increase because the industry is turning to use processes which do not produce waste fuels. Approximately 30% of energy would be produced by domestic fuels. Environmental factors might become the critical restriction of energy supply. The rapid increase of fossil fuels might lead to environmentally better desicions in energy region. This might lead to the increased consumption of natural gas, bioenergy and nuclear power. The more effective utilization of energy, the better production technologies and flue gas purification must also be considered. New power plants will be built for production of electric power. The price of electric power will not increase rapidly in spite of demand of better sulphur and nitrogen removal systems which may cause small increase in the prices. Also the price of coal used for production of electric power will increase.

28169 (PB–90-164377/XAB) **Baseline projection data book: 1989 GRI (Gas Research Institute) baseline projection of US energy supply and demand to 2010.** Holtberg, P.D.; Woods, T.J.; Lihn, M.L.; McCabe, N.C. Gas Research Inst., Chicago, IL (USA). Dec 1989. 560p. (GRI–89/0311). Available from NTIS, PC A24/MF A03.

The 1989 baseline projection data book provides backup in tabular form for the 1989 GRI baseline projection of the U.S. Energy Supply and Demand to 2010. Summary tables are presented along with data for the residential, commercial, industrial, electric utility, and transportation sectors; gas supply and prices; and energy prices.

28170 (SEG–CE02905, pp. 8, Paper 18) **Crude oil, an analyst perspective.** Parkhill, R. Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

This paper describes the crude oil market and OPEC's place in it both historically and currently, then relates OPEC to world oil supply and demand, taking into account the projected rise in consumption in the developing countries. The paper concludes that the stabilizing factor in the market has been OPEC and it will continue to have that effect by maximizing its volume, thereby dampening prices in an environment characterized by strong demand. The major problem facing OPEC is that Iraq's crude oil export potential will grow at a much faster rate than the market's demand for OPEC's oil as a whole. Current oil prices or the perception of future oil prices will be sufficiently attractive to convince the industry to boost its exploration and development activities directed towards oil. 2 tabs.

28171 (SEG–CE02905, pp. 15, Paper 17) **Crude oil, an industry perspective.** Goods, R. Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

This paper describes Husky Oil Ltd.'s operations and type of heavy oil, supply and demand in Canada and the northern U.S., pricing, and markets. The paper concludes that the current low price environment for heavy oil prices will continue for the next few years and Canadian domestic demand will not increase substantially unless more upgraders are constructed. Few new major heavy oil commercial enhanced oil recovery (EOR) projects will be economically viable in the next 5-7 years unless oil prices increase substantially and anticipated significant increases in Canadian natural gas prices will have a negative effect upon the economics of heavy oil EOR projects. The differentials between the prices of light and heavy crude oils will increase in future as prices for light crudes increase worldwide and investments in upgrading will yield low but reasonably stable rates of return for investors.

28172 (SEG–CE02905, pp. 36, Paper 16) **Crude oil, industry perspective.** Hobeson, E. Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing

conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

This paper presents an overview of the Canadian and world crude oil industry, focusing on production and reserves, transportation status, and marketing strategy, then identifies the significant trends at work in the marketplace. There is a period of stability ahead which should lead to renewed drilling interest in the near future. In the long term, there is a growing need to become more aggressive and proactive in the marketing of heavy crude oil, leading to the need for increased cracking capacity and possibly pipeline expansions. 16 figs., 11 tabs.

28173 (SEG–CE02905, pp. 12, Paper 14) **Environmental impact on energy prices.** McDiarmid, D.P. (Canatron Inc., Toronto, ON (Canada)). Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

The environmental issues which are likely to provide the greatest impact on energy pricing are: global warming, ozone depletion, ozone increase in elevations below about 6000 feet, and acid rain. The drives moving these issues include forces of international public opinion, particularly American, international protocols developing; government agendas in regulation of chemicals; and sustainable development in a Canadian context. Controls in Reid vapour pressure of fuels ,further sulphur emissions regulations, regulation of benzene, volatile organics, toluene and xylene content of fuels and of the emmission of carbon dioxide and NO_x compounds are expected to be phased in over at least a 2-year period and will definitely increase costs.

28174 (SEG–CE02905, pp. 36, Paper 13) **Interfuel competition, natural gas.** Wauchop, T.S. Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

This paper discussed natural gas markets and pricing in relation to interfuel competition, gas to gas competition, free trade, technological developments, and environmental issues. The paper concludes that oil prices will be soft for the foreseeable future; that interfuel competition, particularly with heavy fuel oil, will continue to limit price increases for natural gas; competition with other fuels (light fuel oil and electricity) will be a factor in setting natural gas prices at the point of sale; the Free Trade Agreement with the U.S. and the introduction of a futures prices contract will add volatility to the Canadian spot market for natural gas; and natural gas will be marketed as the environmentally friendly fossil fuel. 14 figs., 2 tabs., 25 refs.

28175 (SEG–CE02905, pp. 41, Paper 10) **Refined products, an analyst perspective.** Barker, E. Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

This paper discusses the price outlooks for refined petroleum products beginning with a global perspective, then returning to the implications for pricing in Canada. The paper describes supply/demand picture and considers changes in demand by product. A short consideration of the environment leads into a discussion of key indicators, followed by some historical facts about pricing. The result of this is a set of implications for Canadian refiners. The 1992 price forecast covers gasoline, middle distillates, and heavy fuel oil. Price trends for the first two are up, are are sideways for heavy fuel oil. 7 figs., 1 tab.

28176 (SEG–CE02905, pp. 23, Paper 5) **Economic impact on energy prices.** Rheaume, G. (Conference Board of Canada (Canada)). Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

This paper discusses the Board's Canadian economic outlook, including the factors that will influence the energy industry, and the expected effect of the Goods and Services Tax. The slowdown in the Canadian economy is attributable to high interest rates, the increase in taxes, and the trade deficit. The paper discusses the effects of each of these on the energy trade, concluding that the Canadian economy is heading for rough times, with a possible recession in the near future. The implications of the Goods and Services Tax will have much to do with this, and those in the energy business should begin making plans to incorporate it into their financial plans.

28177 (SEG–CE02905, pp. 24, Paper 4) **Future gas prices: Current trends and future factors.** Ziff, P. Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

This paper covers current pricing and trends in western Canada and on the spot market and price forecasts by the 3 major Calgary petroleum engineering firms and the 2 major regulatory agencies (National Energy Board and the Alberta Energy Resources Conservation Board). Prices are predicted to rise overall, eventually leading to a better ratio for oil prices than currently prevails. However, low prices, particularly during the off season, will continue the margin squeeze characteristic of the deflationary energy pricing environment since the early 1980s, placing a premium on efficient corporate performance in both finding and producing natural gas. Factors which influence future prices are then discussed, including oil prices, prices in the U.S., transporation costs, government royalties and taxes, and the future level of supply and demand. Gas drilling in Canada will continue to increase in the 1990s, spurred by new export sales and higher prices. 19 figs., 3 tabs.

28178 (SEG–CE02905, pp. 36, Paper 2) **Natural gas markets in the 1990's: The perspective of an eastern distributor.** Hunter, J.C. (Union Gas Ltd., Chatham, ON (Canada)). Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

This paper covers the market before deregulation (1975-85), reviews activities and events since deregulation, provides an indication of future markets, and makes specific recommendations for both buyers and sellers. The paper predicts that supply will tighten in the next 1-4 years, U.S. penetration of eastern Canadian gas markets will continue, core market direct purchase activity will cease, liquid natural gas imports will play an increasing role in the U.S., environmental issues in North America will enhance natural gas markets over the next decade, and there will be a rebirth of recognition of the value of the Ontario marketplace by western Canadian suppliers. 10 figs., 5 tabs.

28179 (SEG–CE02905, pp. 34, Paper 1) **Natural gas, an industry perspective.** Caughey, G. Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

This paper presents information on Western Gas Marketing, formed in 1985 in anticipation of deregulation in Canada with the

primary responsibility of managing all TransCanada PipeLines' purchase and sales contracts. The paper covers their sales status and regional export sales goals, the benefits to eastern Canadians of deregulation, Ontario natural gas prices, a comparison of the production and supply in Canada and the U.S., and reserves. Beginning in 1990, arbitration will be one method of establishing prices for the core market and will affect up to 60% of Canadian sales. The paper concludes with factors which will affect the market for natural gas in both Canada and the U.S., chief of which are environmental concerns, and difficulties in meeting electric power demand with current generation sources, leading to the need for such cooperative projects as cogeneration. It is concluded that average Alberta border prices will have an upward trend for foreseeable future. 4 figs., 11 tabs.

28180 (SEG–CE02905, pp. 25, Paper 19) **Crude oil, an analyst perspective.** Pullam, P. Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

The paper describes the factors to be taken into account in forecasting Canadian crude oil prices, the most important of which is the isolated developments in the U.S. midwest region, since this area is Canada's alternative market. Other variables include WTI prices, weather, and economic growth. The world forecast is for weak prices over the next several months as a result of OPEC disunity and lower-than-anticipated demand, followed by a sustained upward move through the 1990s fuelled by tightness in the U.S. midwest and steady increases in the overall demand for OPEC's crude. For Canada, cautious optimism is indicated although the crude oil price outlook looks good in the long term.

28181 (SEG–CE02905, pp. 18 Paper 3) **Natural gas pricing outlook.** McGarvey, P. Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

This paper covers the current status of gas/oil competition in U.S. markets, using comparisons in burner tip price equivalency in utilities and the industrial sector; then moves to the impact of future demand and supply on this competition in light of the growing electrical demand; the new clean air proposals; the concern for security of energy supplies; the declining gas supply; and the rising finding, development and transactions costs. Forecasts are given for the U.S. and Canada. The paper concludes that with tightening supply/demand, gas prices have the potential to close the gap with residual fuel oil prices; U.S. natural gas demand for electricity generation will double and environmental legislation will enhance the economics of using natural gas; Proved gas reserves in the lower 48 states are declining, finding and development costs will rise by 10% per year, and Canadian gas prices into export and eastern domestic markets will increase more rapidly than U.S. gas prices due to transportation leverage. 18 figs., 4 tabs.

28182 (VTT-TIED–1066) **Energy scenarious in growing economy.** Seppaelae, Y. (Valtion teknillinen tutkimuskeskus, Espoo (Finland). Yhdyskunta- ja rakennussuunnittelun laboratorio). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Oct 1989. 149p. (In Finnish). Order Number DE90770756. Available from NTIS (US Sales Only), PC A07/MF A01.

Completed during the years 1988-1989, the study Finnish Energy Supply in the medium and overlong term using the most up-to-date futures research techniques and was concerned with examining Finnish energy system from a global viewpoint. The target years was taken to be 2005 with 2030. The method employed was Basics (Battelle Scenario Inputs to Corporate Strategies) developed by the international research institute Battelle. A detailed description of the method is presented in this report. Both medium and overlong term energy models were compiled in connection with the project. From these, several scenarios were calculated. In particular, the resulting predictions emphasized the impact of economic growth and the development of energy technics on the supply of energy and its environmental effects. Generally speaking, the scenarios seemed to be optimistic with respect to growth. In considering the world as a whole, the effect of the future energy strategies of developing countries were stressed in the results obtained from the overlong term model. In sensitivity and impact analyses linked to the future visions, the effects of energy prices, decreasing emissions and their cleaning, environmental catastrophes and innovations in energy technology on energy systems and inter-related economies and environments were also clarified.

2930 Policy, Legislation, and Regulation

Refer also to citation(s) 27614, 27981, 28011, 28144, 28187

28183 (SEG–CE02905, pp. 15, Paper 15) **Energy prices: A government perspective.** Howe, B. Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

This paper first discusses energy policy in Canada over the past 30 years for oil, natural gas, uranium, coal, and electricity, then looks at issues which will influence future policy. Emerging trends include the success of market-oriented energy policies, leading to pressures toward a non-interventionist approach on the part of government; a more cooperative approach between the federal and provincial governments in interprovincial electricity trade and exports; possible intervention in domestic oil prices, dependant more on U.S. policy than any other factor; and a growing attention to the relationship between energy and the environment, including incentives and taxation. 1 tab.

2940 Fossil Fuels

Refer also to citation(s) 27421, 27447, 27458, 27461, 27462, 27512, 27513, 27514, 27517, 27524, 27535, 27560, 27572, 27573, 27581, 27589, 27611, 27612, 27613, 27614, 27645, 27647, 27648, 28147, 28170, 28171, 28172, 28174, 28175, 28177, 28178, 28179, 28180, 28181, 29032

28184 (SEG–CE02905, pp. 24, Paper 12) **Interfuel competition, refined fuels.** Samain, S. Southam Energy Group, Toronto, ON (Canada). [1990]. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

This paper presents an overview of supply/demand conditions and an outlook on pricing conditions expected for refined fuels in eastern Canada and the U.S. east coast. It is assumed that crude oil prices will remain flat well into the 1990s, giving little incentive for investment and development in non-conventional supply such as offshore projects, tar sands production, and tertiary recovery. Refined product prices will tend to follow the ups and downs of crude competitive forces, with eastern Canada prices influenced also by the ability of products to move in and out of the market as opportunities occur. There will be little movement toward alternate transportation fuels. 15 figs., 3 tabs.

28185 (SEG–CE02905, pp. 33, Paper 9) **Refined fuels, an analyst perspective.** Plexman, R. Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

The paper discusses the economic and financial aspects of the Canadian petroleum products outlook, beginning with a review of the major supply, demand and profit trends. Important variables in the future include the demand for the 4 major petroleum products, the cost of crude oil for refiners, the fragmentation of the Canadian market into 4 regions, each different, refinery capacity utilization

rates, import/export balances, and inventories of crude oil and products. The outlook indicates that petroleum product consumption will maintain a positive trend although rising at a lower rate than heretofore; Shell Canada's results will improve, reflecting a return to more normal operations; some of the synergies from Imperial's purchase of Texaco Canada will become more evident; refining capacity utilization rates will remain high across the country; and oil prices (refiner costs) will remain relatively stable. 16 tabs.

28186 (SEG–CE02905, pp. 36, Paper 8) **Refined fuels, an industry perspective.** Shannon, D. Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets*. Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

This paper describes the refined fuels industry and the pressures on it, its size and profitability, product flows, supply, the world market, costs, and price performance. The positive aspects are identified as more buoyant demand outlook, growth in the petroleum supplied transportation sector, a better balance in product supply/demand, and improved refinery utilization. Minuses include the large capital expenditures required for enviromental concerns, higher economic costs when returns are already low, a continuous global competitive environment, and the propensity of governments to tax transportation fuels. 19 figs.

28187 **Can a more competitive natural gas industry provide stability.** Hanson, D.A. (Argonne National Lab., IL (USA)); Jennings, T.V.; Lemon, J.R. pp. 430 of Proceedings of the twenty-sixth annual Allerton conference on communication, control, and computing. International Assoc. of Energy Economists, Washington, DC (USA) (1988). (CONF-8810108–: 10. annual North American conference of the International Association for Energy Economics, Houston, TX (USA), 30 Oct - 2 nov 1988).

The U.S. Department of Energy (DOE) sponsored an assessment of the natural gas resource base, a description of which is included in this paper (U.S. DOE, 1988). This assessment is intended to provide those investing in gas facilities with a sense of confidence that scarcity of gas and curtailments that characterized the regulated gas environment need no longer be a concern, provided prices are set by free markets to balance supply and demand. This paper addresses the question, Can a more competitive natural gas industry provide stability? The authors discuss a free gas market, primarily referring to a market in which flexible, accurate prices are free to adjust to achieve market equilibrium – a balance of supply and demand.

2950 Hydrogen and Synthetic Fuels

Refer also to citation(s) 28155, 28156, 28208, 28342

2960 Electric Power

Refer also to citation(s) 27862, 27870, 27873, 27876, 27877, 27952, 28092, 28095, 28100, 28104, 28122, 28123, 28228, 28232, 28234, 28287

28188 (DOE/BP–1358) **Energy Savings Plan: Preliminary redesign proposal.** USDOE Bonneville Power Administration, Portland, OR (USA). Mar 1990. 33p. Sponsored by U.S. DOE Conservation & Renewable Energy. Order Number DE90009378. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We intend this document to be a starting point for discussion on how best to redesign ESP. Our intent is to present ideas, have you consider them, and have you suggest what improvements can be made so we can jointly design a better program. This document is not meant to be a full-blown program description document. We are not trying to provide final answers for all the issues we raise, although we do suggest possibilities for resolving some of them. Some of the more intriguing issues we've identified so far include:What should an "Energy Review" (a form of energy analysis) consist of? How should program administrative costs be balanced against project incentive and rebate costs? How should first-year energy savings in new and expanding industrial facilities be calculated? How can we appropriately guard against financing "free-rider" projects — those that would have been installed absent the program incentive? What degree of control should Bonneville have over utility-operated programs? Should a utility operating ESP be required to offer all program services — Energy Reviews, motor rebates, and incentives? 1 fig.

28189 (DOE/BP/63406–7) **The effects of climate change on energy planning and operations in the Pacific Northwest: Volume 1, Overview: Final report.** Wade, J.E. (Oregon State Univ., Corvallis, OR (USA). Energy Resources Research Lab.); Redmond, K.; Klingeman, P.C. Oregon State Univ., Corvallis, OR (USA). Energy Resources Research Lab. Aug 1989. 56p. Sponsored by U.S. DOE Management & Administration. DOE Contract BI79-86BP63406. (BPA–89-29-Vol.1). Order Number DE90009464. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report the first of two volumes, is an examination of Bonneville Power Administration's access to and use of climate information. Widespread concern about global warming and uncertainty about future energy scenarios underscore the influence of climate on energy planning and management. Refinement of scientific theories and computer data capabilities provide unprecedented opportunities for technical capability building and improved management decisions. BPA's decade of examining the availability and feasibility of wind energy has led to fundamental questions about the adequacy and potential of climate awareness. This inquiry prompted a five-month survey by Oregon State University's Energy Resources Research Laboratory (ERRL), with extensive input from the Oregon Water Research Institute and the Oregon State Climatologist. Investigators from the ERRL have worked with BPA since 1975, gaining uncommon insight to needs and concerns of utilities in general and BPA in particular. 14 figs., 2 tabs.

28190 (DOE/BP/63406–8) **The effects of climate change on energy planning and operations in the Pacific Northwest: Volume 2, Technical background: Final report.** Wade, J.E. (Oregon State Univ., Corvallis, OR (USA). Energy Resources Research Lab.); Redmond, K.; Klingeman, P.C. Oregon State Univ., Corvallis, OR (USA). Energy Resources Research Lab. Sep 1989. 152p. Sponsored by U.S. DOE Management & Administration. DOE Contract BI79-86BP63406. (BPA–89-29-Vol.2). Order Number DE90009465. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

This report, the second of two volumes, is an examination of Bonneville Power Administration's access to and use of climate information. Widespread concern about global warming and uncertainty about future energy scenarios underscore the influence of climate on energy planning and management. Refinement of scientific theories and computer data capabilities provide unprecedented opportunities for technical capability building and improved management decisions. BPA's decade of examining the availability and feasibility of wind energy has led to fundamental questions about the adequacy and potential of climate awareness. This inquiry prompted a five-month survey by Oregon State University's Energy Resources Research Laboratory (ERRL), with extensive input from the Oregon Water Research Institute and the Oregon State Climatologist. Investigators from the ERRL have worked with BPA since 1975, gaining uncommon insight to needs and concerns of utilities in general and BPA in particular. 111 refs., 93 figs., 11 tabs.

28191 (DOE/BP/63406–11) **Integration of wind energy into the electrical utility system: An overview of the issues: Final report.** Wade, J.E. (Oregon State Univ., Corvallis, OR (USA). Energy Resources Research Lab.); Walker, S.N.; Baker, R.W. US-DOE Bonneville Power Administration, Portland, OR (USA). Div. of Resource Management; Oregon State Univ., Corvallis, OR (USA). Energy Resources Research Lab. Feb 1990. 35p. Sponsored by U.S. DOE Management & Administration. DOE Contract BI79-86BP63406. (BPA–89-32). Order Number DE90009468. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report examines the issues related to integration of wind energy into the utility system grid. In California alone there are nearly 17,000 wind turbines with ratings over 17.5 kW. The changing nature of the wind and reactive power demands of the predominantly induction wind generators will present a number of integration

challenges for utilities. The Pacific Northwest is endowed with substantial wind energy resources. Integrating this resource into our utility systems will require planning to resolve the technical problems that affect safety, economics, system stability and overall system reliability. Integration problems in this report will be examined from the point of view of the quantity of energy available, its value to a utility and the quality of energy delivered. 82 refs., 1 fig.

28192 (EGG-M–89411) **Assessing mission goals and customer needs.** Gregg, R.E.; Reny, D.A. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 4p. Sponsored by U.S. Department of Defense. DOE Contract AC07-76ID01570. (CONF-900628–1: 17. international conference for the electric power industry: reliability, availability, maintainability strategies for the 90's, Hershey, PA (USA), 12-15 Jun 1990). Order Number DE90009646. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper discusses work performed for the US Air Force Space Command at the Idaho National Engineering Laboratory. In conducting facility analyses, there is a need for open and complete communication between the customer and the analyst. With good lines of communication established, the analyst will be able to properly, assess the customer's needs. Once the customers needs are defined, an analysis can be performed that accurately models a facility's ability to fulfill its mission goals. The analyst can then provide the results of the analysis in a format that the customer can easily interpret and use. The customer can then make informed decisions about a facility's vulnerabilities and potential improvements. To this end, if the customer plans on using a number of different contractors to provide analyses, it will benefit the customer to have a set of guidelines available that detail what is expected from an analysis. 2 refs.

28193 (EPRI-CU–6706) **Home automation: What's in it for utilities?: Final report.** Levy, R.D. (Levy Associates, Sacramento, CA (USA)); Parks, T. Electric Power Research Inst., Palo Alto, CA (USA); Levy Associates, Sacramento, CA (USA). c Apr 1990. 63p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report examines how home automation products might be used to facilitate and expand the load shaping and customer service capabilities of utility load management programs. It also addresses a range of programmatic issues that suggest home automation may be a viable substitute for conventional direct control programs. General functional capabilities, trends, and the strengths and weaknesses in current utility load management programs are discussed. Similar information is also presented for home automation products. Summary information on four categories of typical home automation equipment provides an overview of key product features and capabilities. Trends in the appliance and electronics industry indicate that home/building environmental systems will increasingly include microprocessor based logic functions as standard features. A comparison of functional capabilities concludes that present day utility direct control programs conflicts with resident logic/processor functions once these environmental systems are in place. In contrast, home automation systems are designed to work in concert with and complement resident logic/processor functions. This report also identifies increased activity by national and international companies to market home automation products and a variety of related energy management, information, and lifestyle enhancing services. All provide energy management applications to generate savings that cost justify customer purchase decisions. 17 FIGS., 10 TABS.

28194 (EPRI-EM–5907) **Residential customer preference and behavior: CLASSIFY™ and PULSE® technical guide: Final report.** Electric Power Research Inst., Palo Alto, CA (USA); National Analysts, Inc., Philadelphia, PA (USA). c Mar 1990. 73p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Customer Preference and Behavior (CP&B) Project is designed to satisfy two chief objectives of electric utility managers concerned with demand-side management (DSM): To organize utility customers into submarkets or segments on the basis of their energy-related needs; and to provide tools for evaluation and targeting DSM program options; as part of the CP&B Project,two software tools were developed to meet these objectives for the residential sector: CLASSIFY (customer segmentation); and PULSE (evaluation and targeting DSM program options). This guidebook describes the modeling analyses associated with the development of CLASSIFY and PULSE. It provides enough detail for the reader for the reader to understand thoroughly how the residential survey data were analyzed and the tools developed. With this understanding, electric utility managers can apply these techniques and/or repeat them on other databases. 33 figs., 2 tabs.

28195 (EPRI-OCSP–6757) **Proceedings: 1989 utility strategic issues forum: What does the future hold for the electricity business?** Feher, J.S. (comp.). Electric Power Research Inst., Palo Alto, CA (USA). c Mar 1990. 391p. Sponsored by Electric Power Research Institute. (CONF-8904335–: 2. EPRI annual utility strategic issues forum: what does the future hold for the electricity business?, Kansas City, MO (USA), 11-12 Apr 1989). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

EPRI's second annual Utility Strategic Issues Forum was held in Kansas City, Missouri on April 11 and 12, 1989. The primary purpose of the Forum was to present and discuss strategic issues related to utility business and strategic planning. The theme for this year's forum was "What Does the Future Hold for The Electricity Business?" To promote a better understanding of the planning issues related to this theme, we designed the following seven sessions; general overview session; transmission and power markets in the future; the future of fuels and electric utilities; environmental issues; help for planning for the future; the role of information and communication technologies and pricing in utilities competitive future; and a financial view of the future. The Forum combined results from EPRI research coupled with novel concepts and ideas considered or implemented by utilities, government agencies, consultants and others. Each report will be cataloged individually.

28196 (PB–90-159153/XAB) **Electric power wheeling and dealing: Technological considerations for increasing competition. Volume 2. Contractor documents.** Ohio Public Utilities Commission, Columbus, OH (USA). 1988. 1218p. Available from NTIS, PC EE99/MF E99.

Set includes PB–90-159161 through PB–90-159195.

A separate abstract is included for each of the 4 parts of this volume.

28197 (PB–90-159161/XAB) **Electric power wheeling and dealing: Technological considerations for increasing competition. Volume 2. Contractor documents, Part A.** Ohio Public Utilities Commission, Columbus, OH (USA). 1988. 263p. Available from NTIS, PC A12/MF A02.

See also Volume 2, Part B, PB–90-159179; Also available in set of 4 reports PC E99/MF E99, PB–90-159153.

The report surveys states for procedures and problems on siting generating and transmission facilities and for planning future electric power growth. Contents: Transmission line certification and siting procedures and energy planning processes; Electric utility generation and transmission planning and coordination; Summary of responses of the regional reliability councils to the National Governors' Association Survey on electric transmission coordination and planning; Planning and coordination of utility bulk power supplies and transmission capacity. Appendix 1 contains additional comments by respondents.

28198 (PB–90-159179/XAB) **Electric power wheeling and dealing: Technological considerations for increasing competition. Volume 2. Contractor documents, Part B.** Casazza, Schultz and Associates, Inc., Arlington, VA (USA). 1988. 511p. Available from NTIS, PC A22/MF A03.

See also Volume 2, Part A, PB–90-159161 and Volume 3, Part C, PB–90-159187; Also available in set of 4 reports PC E99/MF E99, PB–90-159153.

The report reviews the technologies for electric power transmission and how it is employed by utilities. Contents: Case studies on increasing transmission access; Case studies of transmission bottlenecks; Technological considerations in proposed scenarios for increasing competition in the electric utility industry; Technical background and considerations in proposed increased wheeling, transmission access and non-utility generation.

28199 (PB–90-159187/XAB) **Electric power wheeling and dealing: Technological considerations for increasing competition. Volume 2. Contractor documents, Part C.** Investor Responsibility Research Center, Washington, DC (USA). 1988. 241p. Available from NTIS, PC A11/MF A02.

See also Volume 2, Part B, PB–90-159179 and Volume 2, Part D, PB–90-159195; Also available in set of 4 reports PC E99/MF E99, PB–90-159153.

The report reviews several of the important factors affecting the electric power industry and the relationship with increased competition. Contents: Competition and the role of the capital markets in restructuring the electric power industry; The siting of EHV electric transmission lines; Environmental effects of increased competition in the electric power industry; Economic and planning implications of the FERC notice of proposed rulemakings on independent power producers: a review of documentation.

28200 (PB–90-159195/XAB) **Electric power wheeling and dealing: Technological considerations for increasing competition. Volume 2. Contractor documents, Part D.** Boston Pacific Co., Inc., Washington, DC (USA). 1988. 203p. Available from NTIS, PC A10/MF A02.

See also Volume 2, Part C, PB–90-159187; Also available in set of 4 reports PC E99/MF E99, PB–90-159153.

The report surveys selected utilities on their experiences with and preparations for increased competition. Contents: Survey of utilities reactions to increased competition; Competitive procurement of generating capacity–summary of procedures in selected states.

28201 (SEG–CE02905, pp. 31, paper 11) **Interfuel competition, electricity.** Conway, B. Southam Energy Group, Toronto, ON (Canada). Oct 1989. (CONF-8910388–: 9. annual energy pricing conference, Toronto (Canada), 12-13 Oct 1989; CE–02905). In *The ninth annual energy pricing conference: Analyzing Canadian prices and markets.* Available from Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN.

This paper discusses the pricing and use of electricity in competition with other fuels, and describes the programs currently run by Ontario Hydro in demand management. This includes time-of-use rates, incentive programs consisting of energy audits and financial help for the purchase of more efficient lighting equipment and motors, and accelerated pay-backs for industry. 11 figs.

28202 Incorporating uncertainty into electric utility long-term planning and decision making. Hirst, E. (Oak Ridge National Lab., TN (USA)). VP of Planning and forecasting. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). DOE Contract AC05-84OR21400. (CONF-8808247–: Planning and forecasting, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

This paper discusses uncertainty as it affects the planning and acquisition of demand and supply resources by electric utilities. The basic elements of uncertainty and definitions of key terms are given to illustrate diverse types of uncertainties associated with different resources and with diverse types of uncertainties associated with different resources and with the utility's external environment. Various analytical methods employed by utilities to treat uncertainty by focusing more on the decision making process (and therefore less on the simulation of utility operations and finances). An example is presented that shows how a particular resource (programs aimed at improving efficiency of new buildings in this case) can affect other uncertainties that affect decisions.

28203 Closing the loop on uncertainty: Does Bonneville's conservation policy analysis model make HYPERSENS. Bull, M. (Bonneville Power Administration (US)); Ford, A. vp. of Planning and forecasting. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808247–: Planning and forecasting, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

This paper summarizes key findings from recent model-assisted studies of conservation strategies for reducing system planning uncertainties in the Pacific northwest. Bonneville's conservation policy analysis model (CPAM) was used to study uncertainty in both electric loads and electric rates. The paper describes the study methodoloy which entails the use of a statistical sampling and analysis package, called HYPERSENS, to generate a formal analysis of sampling uncertainty. Primary economic drivers, such as, regional growth, profitability of aluminum smelter operation, and retail utility decision making on whether to buy wholesale power from Bonneville, are some of the factors investigated in the study. The focus of the paper is on the value of conservation programs, particularly conservation standards which require greater efficiency of gas and electricity use in new buildings. The authors show that standards can significantly reduce uncertainties in both electric loads and electric rates, and we explain a simple method to estimate the relative benefit of reduced uncertainty.

28204 Load management alternatives to transmission and distribution construction. Englin, J.E. (Pacific Northwest Lab. (US)); DeSteese, J.G. vp. of Planning and forecasting. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808247–: Planning and forecasting, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

This paper presents results of the conservation-in-lieu-of-construction (CILOC) Study undertaken for Bonneville power administration. The objective was to assess the potential for end-use load management to defer the need for new transmission and distribution (T and D) construction in areas experiencing electric load growth. Software was developed for this purpose and applied to the Toledo-Wren area of Oregon, as a test case. The CILOC potential of residential water heater controls, ceramic space heaters and the combined effect of both options was evaluated. The combined effect of both measures was shown to be a lower cost alternative to new T and D construction for up to 9 years. Individually, the options were effective between 4 and 8 years, depending on the industrial growth scenario considered. The results indicate that, in cases where there is isolated load growth, load management can be a visible alternative to T and D construction.

28205 Changing needs in electricity demand forcasting: A California perspective. Eto, J. (Lawrence Berkeley Lab., CA (USA)); Blumstein, C.; Jaske, M. vp. of Planning and forecasting. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808247–: Planning and forecasting, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

The forces of deregulation and integrated resource planning are causing changes in the role of electricity demand forecasts. In this paper, the experience of California since the early 1970's provide a background for a discussion of these changes. Taken together, these changes have created challenges for electricity demand forecasters. The authors identify load shapes, the effects of rate structure, consumer behavior, and customer data, according to this analysis, a renewed commitment to forecasting research and development appears to be required.

2980 Consumption and Utilization

Refer also to citation(s) 28168, 28956

2990 Unconventional Sources and Power Generation

Refer also to citation(s) 27788, 27820, 27826, 27830, 28150, 28154, 28155, 28156

28206 (PJM–CE02952, pp. 84-90, Paper 15) **Using the FIRE [Forest Industry Renewable Energy] program.** Robert, J. (Energy, Mines and Resources Canada, Ottawa, ON (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The Forest Industry Renewable Energy (FIRE) program has as its objective to encourage the use of wood and other biomass fuels for the generation of energy. This paper contains a description of the program and how applications are received by the department. Typical projects involve the direct combustion or gasification of biomass, conversion of biomass to prepared solid fuels, or cogeneration. The main criteria for inclusion of a project in the program that it must contribute to the reduction to demand of oil fuel and

the use of renewable energy. Electricity in this sense is termed renewable. If public money has been obtained from other agencies to subsidize the project, it becomes ineligible. Eligible cost include: all direct capital costs for combustion systems, site preparation and equipment foundations, materials handling equipment; fuel preparation and processing equipment; and direct labor for installation. The costs of buildings to house the project are also eligible. The total cost and profitability of the project is calculated. If the payback period is less than 2 years it is ineligible for a grant. If it is equal to two years, the grant is 10%. Projects with a payback greater than 2 years are eligible for a 20% grant. The FIRE contribution is subject to 10% holdback. The project must pass a final audit and a final engineering inspection before the 10% holdback is released. To date 120 projects have been approved with a commitment of over $58 million dollars.

28207 (PJM–CE02952, pp. 91, Paper 16) **Legal aspects of the FIRE [Forest Industry Renewable Energy] program.** Juneja, S. (Energy, Mines and Resources Canada, Ottawa, ON (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: Conference on biomass - an alternate source of energy, Vancouver (Canada), 8 Nov 1982; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper describes the legal obligations associated with participation in the Forest Industry Renewable Energy (FIRE) program. Once a project is approved, the recipient is required to sign a contribution agreement with the Department of Energy, Mines, and Resources (EMR). In return for the grant the recipient is expected to complete the project on time. If the program falls behind schedule, the department should be notified an explanation given. A project is deemed complete when it has operated for 30 days at 50% capacity. An engineering inspection is required to ensure that the project was done in accordance with submissions. The grant is provided in the form of progress payments. An invoice and a progress report are required every three months. The contract requires that the recipient allow visiting rights to the project on the part of EMR personnel and other interested parties.

28208 (PJM–CE02952, pp. 105-112, Paper 20) **An international perspective.** Tuvell, R. (California Energy Commission, Sacramento, CA (USA)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper describes the activities of California public agencies in promoting the use of biomass energy. Also included are a description of several successful projects which have received public support. The primary function of the California Energy Commission (CEC) is to ensure that there is sufficient supply mix to meet demand and to ensure that the type of energy available is coincident with California's public interest. It is a policy making body. The California Public Utilities commission is primarily concerned with rate establishment. California has 143,000,000 barrels of oil equivalent available from biomass, mostly from agricultural crop and industry residues, of which 5% is being used. The primary incentives for the use of biomass fuels are described. In the USA utilities are required to pay avoided costs to small power producers for self-generated energy. A 10% investment tax credit and a 10% energy tax credit is also available to small energy producers. The rising cost of fossil fuel and electrical energy form another incentive. Disincentives include the newness of the technology, and environmental considerations. The CEC response has been to develop demonstration programs to prove the technology and calm environmental fears. Demonstrations are run under the State Agricultural and Forestry Utilization Act. This five-year program provides interest free loans to projects which feature technology that the CEC is interested in demonstrating. Money may be used for equipment only. Repayment of loans must be made within 90 days of project completion. If the project is unsuccessful the loan is forgiven.

28209 (SLU-IMB–40, pp. 138-142) **Biogas technology - an important link in environmentally sound management of wastes.** Szikriszt, G. (Biomet AB, Sundbyberg (SE)); Frostell, B. Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish). (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

Biogas technology is an interesting alternative for organic waste stabilization in a future waste treatment system. This is especially the case if organic wastes are collected as concentrated and uncontaminated as possible. Proposedly, food waste should be collected separately at the household level together with toilet waste from water conserving systems. Despite this being a future vision, there is already today a considerable amount of waste available that would suit the concept. Wastes from restaurants, ships, airplanes, summer-houses, grocery shops etc. are good examples. An economic analysis showed that rather large plants would be necessary to achieve a profitable system if credit is given to the biogas only. If alternative waste handling costs and the fermentation residue are also valued however, there is a potential to construct also small profitable plants.

28210 (STEV–1989-R3) **IEA Bioenergy Annual Report 1988.** Statens Energiverk, Stockholm (Sweden). 31 Jan 1989. 70p. Order Number DE90770867. Available from NTIS (US Sales Only), PC A04/MF A01.

During 1988 the number of Contracting Parties to the IEA Bioenergy Implementing Agreement increased from twelve to thirteen by Italy's signing of the Agreement. The twentyfirst EC meeting took place in Oxford, U.K. on May 10-11, 1988. The twentysecond EC meeting was held in Jyvaeskylae, Finland on September 20-21, 1988. The three ongoing Tasks have formal duration until April 30, 1989: * Improvement of Biomass Growth and Production Technology in Short Rotation Forestry for Energy; * Development of Improved Methods for Harvesting, Processing and Transport of Forest Biomass for Energy from Conventional Forests; * Improvement of Methods for Converting Biomass Feedstocks into Usable Energy forms. Three new Tasks were started on January 1, 1989 and will have a duration of three years: * Improvement of Energy-Dedicated Biomass Production Systems; * Biomass Supply from Conventional Forestry; * Improvement of Methods for Conversion of Biomass Feedstocks. A short bibliography on report from the tasks is given.

28211 **Electricity markets and the outlook for renewable energy.** Swezey, B.G. (Solar Energy Research Inst., Golden, CO (USA)). pp. 430 of Competition, profitability, and policy in the energy industries. International Assoc. of Energy Economists, Washington, DC (USA) (1988). (CONF-8810108–: 10. annual North American conference of the International Association for Energy Economics, Houston, TX (USA), 30 Oct - 2 nov 1988).

Driven both by PURPA and R and D progress, renewable energy-based electricity generating technologies have shown marked improvement in cost and performance over the last several years. However, at the same time, the competitive thresholds that supply technologies must reach to significantly penetrate energy supply markets have become more stringent. This paper examines these recent energy market trends and provides a perspective on the continued potential of renewable energy technologies to make a significant contribution to power supply. Also discussed are the implications of the ongoing restructuring of the electric utility industry, including least cost utility planning and the move toward competitive bidding for electricity supply, and increasing global environmental concerns.

30 DIRECT ENERGY CONVERSION

3001 MHD Generators

Refer also to citation(s) 27488

28212 (DOE/PC/70507–T2-Pt.1) **MHD channel development: Final report, 25 April 1984–31 December 1988: Part 1.** Avco-Everett Research Lab., Everett, MA (USA). Dec 1989. 363p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-84PC70507. Order Number DE90009549. Available from NTIS, PC A16/MF A01 - OSTI; GPO Dep.

This is the final report of work performed by Avco Research Laboratory, Inc. for the US Department of Energy, Pittsburgh Energy Technology Center. The overall objectives of this program were: to contribute, by appropriate systematic experimental and analytical investigations, to the engineering data base necessary for the design and construction of MHD generators at the 50 MW_{th} and ultimately at commercial sizes; and to design and fabricate specific hardware items to be tested at a site to be specified by DOE. The program consisted of a series of related tasks, which are described in subsequent sections of this report. Section 2.0 summarizes the important results of the entire program. Sections 3.0 through 7.0 describe the work in detail, and are organized as follows: Section 3.0, MHD Channel Design and Performance, reports experimental and analytical investigations related to MHD channel design and performance. Section 4.0, MHD Channel Construction and Lifetime, reports experimental investigations related to MHD channel reliability and lifetime, where the principal aim is to improve the constructability, maintainability, and reliability of coal-fired, long-duration MHD channels. Section 5.0, MHD Channel Loading and Control, reports on the analysis, testing and fabrication of channel loading and control circuits. Section 6.0, Facility Operation, describes the facilities and operation and maintenance of the Mk VI and VII test bays. Section 7.0, DOE Test Facility Technical Support, reports on the results of the data reduction and analysis of the CDIF generator test data.

28213 (DOE/PC/70507–T2-Pt.2) **MHD channel development: Final report, 25 April 1984–31 December 1988: Part 2.** Avco-Everett Research Lab., Everett, MA (USA). Dec 1989. 366p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-84PC70507. Order Number DE90009550. Available from NTIS, PC A16/MF A01 - OSTI; GPO Dep.

This is the final report of work performed by Avco Research Laboratory, Inc. for the US Department of Energy, Pittsburgh Energy Technology Center. The overall objectives of this program were: to contribute, by appropriate systematic experimental and analytical investigations, to the engineering data base necessary for the design and construction of MHD generators at the 50 MW_{th} and ultimately at commercial sizes; and to design and fabricate specific hardware items to be tested at a site to be specified by DOE. The program consisted of a series of related tasks, which are described in subsequent sections of this report. Section 2.0 summarizes the important results of the entire program. Sections 3.0 through 7.0 describe the work in detail, and are organized as follows: Section 3.0, MHD Channel Design and Performance, reports experimental and analytical investigations related to MHD channel design and performance. Section 4.0, MHD Channel Construction and Lifetime, where the principal aim is to improve the constructability, maintainability, and reliability of coal-fired, long-duration MHD channels. Section 5.0, MHD Channel Loading and Control, reports on the analysis, testing and fabrication of channel loading and control circuits. Section 6.0, Facility Operation, describes the facilities and operation and maintenance of the Mk 6 and 7 test bays. Section 7.0, DOE Test Facility Technical Support, reports on the results of the data reduction and analysis of the CDIF generator test data.

28214 (DOE/PC/70507–T2-Pt.3) **MHD channel development: Part 3: Final report for the period April 25, 1984–December 31, 1988.** Avco-Everett Research Lab., Everett, MA (USA). Dec 1989. 165p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-84PC70507. Order Number DE90009551. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This is the final report of work performed by Avco Research Laboratory, Inc. for the US Department of Energy, Pittsburgh Energy Technology Center. The overall objectives of this program were: to contribute, by appropriate systematic experimental and analytical investigations, to the engineering data base necessary for the design and construction of MHD generators at the 50 MW_{th} and ultimately at commercial sizes; and to design and fabricate specific hardware items to be tested at a site to be specified by DOE. The program consisted of a series of related tasks, which are described in subsequent sections of this report. Section 2.0 summarizes the important results of the entire program. Sections 3.0 through 7.0 describe the work in detail, and are organized as follows: Section 3.0, MHD Channel Design and Performance, reports experimental and analytical investigations related to MHD channel design and performance. Section 4.0, MHD Channel Construction and Lifetime, reports experimental investigations related to MHD channel reliability and lifetime, where the principal aim is to improve the constructability, maintainability, and reliability of coal-fired, long-duration MHD channels. Section 5.0, MHD Channel Loading and Control, reports on the analysis, testing and fabrication of channel loading and control circuits. Section 5.0, MHD Channel Loading and Control, reports on the analysis, testing and fabrication of channel loading and control circuits. Section 6.0, Facility Operation, describes the facilities and operation and maintenance of the Mk 6 and 7 test bays. Section 7.0, DOE Test Facility Technical Support, reports on the results of the data reduction and analysis of the CDIF generator test data.

28215 (DOE/PC/70507–T2-Pt.4) **MHD channel development: Final report, 25 April 1984–31 December 1988: Part 4.** Avco-Everett Research Lab., Everett, MA (USA). Dec 1989. 323p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-84PC70507. Order Number DE90009552. Available from NTIS, PC A14/MF A01 - OSTI; GPO Dep.

This is the final report of work performed by Avco Research Laboratory, Inc. for the US Department of Energy, Pittsburgh Energy Technology Center. The overall objectives of this program were: to contribute, by appropriate systematic experimental and analytical investigations, to the engineering data base necessary for the design and construction of MHD generators at the 50 MW_{th} and ultimately at commercial sizes; and to design and fabricate specific hardware items to be tested at a site to be specified by DOE. The program consisted of a series of related tasks, which are described in subsequent sections of this report. Section 2.0 summarizes the important results of the entire program. Section 3.0 through 7.0 describe the work in detail, and are organized as follows: Section 3.0, MHD Channel Design and Performance, reports experimental and analytical investigations related to MHD channel design and performance. Section 4.0, MHD Channel Construction and Lifetime, reports experimental investigations related to MHD channel reliability and lifetime, where the principal aim is to improve the constructability, maintainability, and reliability of coal-fired, long-duration MHD channels. Section 5.0, MHD Channel Loading and Control, reports on the analysis, testing and fabrication of channel loading and control circuits. Section 6.0, Facility Operation, describes the facilities and operation and maintenance of the Mk VI and VII test bays. Section 7.0, DOE Test Facility Technical Support, reports on the results of the data reduction and analysis of the CDIF generator test data.

28216 (DOE/PC/70508–T4) **Coal-fired MHD [magnetohydrodynamics] combustor development project, Phase 3D: Final technical report, 30 April 1984–31 May 1987.** TRW Space and Technology Group, Redondo Beach, CA (USA). Applied Technology Div. Oct 1989. 405p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-84PC70508. (MHD–III-89-002). Order Number DE90009554. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

This Final Technical Report presents the results of Phase 3D of the Coal-Fired MHD Combustor Development Project. During Phase 3D, a 50 MW_t combustor first stage (Unit 2) and two second stages were fabricated and tested at TRW with one of the second stage assemblies eventually being shipped to the Component Development and Integration Facility (CDIF) in Butte, Montana for integration and testing with the 50 MW_t first stage combustor (Unit 1). Combustor plus integrated MHD power train testing was accomplished at CDIF with test support and data analysis support from TRW. Testing accomplished at CDIF included both the combustor only testing and the complete combustor/channel power train testing. In addition to the 50 MW_t coal-fired combustor and power train fabrication and testing activities, TRW completed the design of four (4) additional systems relevant to the 50 MW_t MHD

coal-fired combustor. These designs include an electrically isolated slag rejection system, a low preheat coal-fired precombustor, a low preheat coal feed system and an improved slag dump section for the workhorse 50 MW_t combustor. 224 figs., 19 tabs.

3005 Fuel Cells

Refer also to citation(s) 27950, 28254

28217 (PB–90-121880/XAB) **Development of molten-carbonate fuel cell.** Ogoshi, M.; Shimizu, T.; Kobayashi, K.; Hotta, M. Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan). c 1989. 7p. Available from NTIS, PC A03/MF A01.

Included in IHI Engineering Review, Vol. 22, No. 3, 88-93(Jul 1989).

The fuel cell has various merits of highly efficient power generation, cleanliness in power generation and stillness in operation. IHI has been developing the 100 kW Molten Carbonate Fuel Cell (MCFC) stack entrusted by the New Energy Development Organization under the Moonlight Program and is scheduled to complete the task by 1991. It has been participating in the system development of the MCFC Research Association about the control system technology of the 1 MW MCFC pilot plant and the large capacity technology of the coal gasified MCFC power plant. It has been studying the gas recirculation system of the MCFC power plant in collaboration with the Central Research Institute of Electric Power Industry. The paper describes the outline of the development of the 100 kW MCFC stack, 1 MW MCFC pilot plant, 10 kW gas circulation system and 200 kW onsite MCFC cogeneration system.

28218 (PB–90-162157/XAB) **Novel fluorinated acids for phosphoric acid fuel cells. Final report, April 1985-March 1989.** DesMarteau, D.D. Clemson Univ., SC (USA). Dept. of Chemistry. Sep 1989. 25p. Available from NTIS, PC A03/MF A01.

See also PB–89-205082.

A program for the synthesis of strong fluorinated acids was successfully carried out. Many examples of acids were prepared and characterized by NMR, MS, IR and several acids and derivatives were characterized by single crystal X-ray diffraction. Electrochemical testing of selected acids was carried out in collaboration with other contractors and several of the nitrogen acids demonstrated improved performance in laboratory fuel cells either as concentrated aqueous solutions or as additives in 85% phosphoric acid. The concept that fluorinated acid electrolytes can improve fuel cell efficiency due to higher oxygen solubility, lower anion adsorption and resultant improved oxygen reduction kinetics was supported by the work.

28219 (STEV-NYEL–89-7) **District heating cogeneration plants based on SOFC and MCFC: Joint study.** Roy, R.B. (Studsvik Energy, Nykoeping (SE)); Minkov, V.E. Statens Energiverk, Stockholm (Sweden). 1989. 136p. Project STEV-616-031;STEV-411-234. Order Number DE90770773. Available from NTIS (US Sales Only), PC A07/MF A01.

The application of high-temperature fuel cells, SOFC and MCFC, have been evalated in this study for Swedish cogeneration conditions. The best fuel cell systems investigated in this study invariably exhibit plant P/H > 1 (the demand is P/H = 1). This makes the fuel cell cogeneration systems quite attractive in applications where thermal demand has to be matched, and electrical power in excess of local power demand is desirable. (P/H = ratio of the electrical power to thermal power of a cogeneration plant; also used to characterize the demand pattern of a user.) Both SOFC and MCFC in their simple configuration have cost disadvantages in comparison to their traditional competitors (e.g., GT and GT+ST combined). Fuel cell price has to decrease drastically before they can become competetive. It is expected that for small size district heating cogeneration systems (less than 1 MWth) the conventional gas-fired hot-water thermal unit combined with the purchase of grid electricity will continue to enjoy economic advantage over the comparable SOFC/MCFC systems. For larger systems (1-25 MWth), both SOFC+GT and MCFC+GT, especially the former, with their much superior plant P/H ratio and COE values are expected to be very competetive. High temperature fuel cells with ST bottoming sections appear to be on the borderline. (COE = First year cost of electricity after thermal credit.) The best fuel-cell-based cogeneration systems are based on the use of a combined cycle which incorporates high-temperature fuel cells and gas turbines; this system is economically better than the competing GT and GT+ST. However, the high-temperature fuel cells are not expected to be commercialized before 5-10 years from now, but the gas turbines are available right now.

28220 **Direct utilization of hydrocarbon fuels in high temperature solid oxide electrolyte fuel cells.** Singh, P. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center); Ruka, R.J.; George. R.A. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 3. IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899530.

The authors discuss the utilization of hydrocarbon fuels such as methane and bottled natural gas successfully demonstrated in the operation of high temperature solid oxide electrolyte fuel cells.

28221 **Fuel cells for vehicle propulsion applications: A thermodynamic systems analysis.** Kumar, R. (Argonne National Lab., IL (USA)); Krumpelt, M.; Misra, B. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 3. IEEE Service Center, Piscataway, NJ (USA) (1989). DOE Contract W-31109-ENG-38. (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899090.

The liquid- and air-cooled phosphoric acid, the proton exchange membrane, and the monolithic solid oxide fuel cell systems were analyzed for use in vehicle propulsion applications. System efficiency and input energy distribution were examined as a function of electrochemical fuel utilization and other operating parameters. The liquid-cooled phosphoric acid and the monolithic solid oxide fuel cell systems have efficiencies approaching 40%; the air-cooled phosphoric acid and the proton exchange membrane fuel cell offer efficiencies near 30%. Thus the efficiencies of all of these fuel cell systems are much greater than the efficiencies of internal combustion engines. The analysis presented in this paper indicates further that these fuel cells should be operated at the highest practical electrochemical fuel utilization rates for best efficiency and dynamic response, as well as minimum component volume and cost.

28222 **An electrochemical Claus process for sulfur recovery.** Pujare, N.U. (Eltron Research, Inc., Aurora, IL (US)); Tsai, K.J.; Sammuells, A.F. *Journal of the Electrochemical Society (USA)*, 136(12): 3662-3678 (Dec 1989).

Electrochemical oxidation of H_2S to give sulfur and water was achieved at 900°C using fuel cells possessing the general configuration where anode electrocatalysts experimentally investigated for promoting the subject oxidation reaction included WS_2 and the thiospinels $CuNi_2S_4$, $CuCo_2S_4$, $CuFe_2S_4$, and $NiFe_2S_4$. The predominant oxidizable electroactive species present in the fuel cell anode compartment was suggested to be hydrogen originating from the initial thermal dissociation of H_2S ($H_2S \rightleftarrows H_2 + 1/2\ S_2$) at fuel cell operating temperatures. Rapid anode kinetics were found for the anodic reaction with the empirical trend for exchange currents (i_o) per geometric area being found to be $NiFe_2S_4 > WS_2 > CuCo_2S_4 > CuFe_2S_4 \simeq NiCo_2S_4 > CuNi_2S_4$.

28223 **Electrocatalytic oxidations at electrodeposited bismuth (III)-doped beta-lead dioxide film electrodes.** LoCourse, W.R. (Dept. of Chemistry and Ames Lab., Iowa State Univ., Ames, IA (US)); Hsiao, Y.L.; Johnson, D.C.; Weber, W.H. *Journal of the Electrochemical Society (USA)*, 136(12): 3714-3719 (Dec 1989). DOE Contract W-7405-ENG-82.

Heterogeneous rate constants for the anodic oxidation of many inorganic and organic compounds at electrolytically deposited beta-PbO_2 film electrodes in 1.0M $HClO_4$ are increased by doping the oxide with Bi(III). The rate constants at the mixed-oxide electrode rise sharply for a change from 0 to 10 mole percent (m/o) Bi(III) in the electrodeposition solution, and reach a mass transport-limited value for some compounds at 40 m/o Bi(III). Results of kinetic, voltammetric, and spectroscopic studies of these electrodes are

described. In addition, the lifetime of Bi(III)-doped PbO_2 film electrodes is discussed as a function of concentration, rotation speed, analyte, and applied voltage.

28224 Interpretation of kinetic rate data taken in a channel flow cell. West, A.C. (Materials and Chemical Sciences Div., Lawrence Berkeley Lab., and Dept. of Chemical Engineering, Univ. of California, Berkeley, CA (US)); Newman, J. *Journal of the Electrochemical Society (USA)*, 136(12): 3755-3759 (Dec 1989). DOE Contract AC03-76SF00098.

Nonuniform current distribution can complicate the interpretation of kinetic rate measurements. This paper shows explicitly how nonuniformities affect measurements in the flow-channel cell. Results are given for linear and Tafel kinetics and can be used to relate measurable electrochemical quantities to kinetic parameters. In addition to the appropriate polarization parameter, the interpretation of data requires knowledge of the ratio of the two characteristic lengths and the placement of the reference electrode. The analysis assumes that the ohmic potential drop is subtracted from the measurements by the interruption of current, and that concentration variations are negligible.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

3201 Buildings

Refer also to citation(s) 27491, 27644, 27867, 27868, 28167, 28193, 28316, 28336, 29031, 29035, 29250

28225 (BFR-R-107-1989) **Effects of energy saving measures in residential buildings.** Elmroth, A. (Statens Inst. foer Byggnadsforskning, Gaevle (Sweden)); Hjalmarsson, C.; Norlen, U. Swedish Council for Building Research, Stockholm (Sweden). 1989. 204p. (In Swedish). Project BFR-821262-1. Order Number DE90770874. Available from NTIS (US Sales Only), PC A10/MF A01.

The report describes effects of energy conservation retrofits in existing residential buildings obtained from a comprehensive survey. The survey comprises 300 single and multi family houses in seven Swedish regions. The effects of the measures are obtained from before-after measurements carried out in 1982-86. These measured effects are compared with expected effects calculated from data obtained from on-site inspections of the houses. The most important results (averages for groups of houses) are: * The retrofits gave in majority of cases statistically significant energy savings. * The energy savings of heat pump installations in single family houses were 40-60 per cent of pre-retrofit energy consumption (60 per cent for ground-source heat pumps and 40 per cent for outdoor air-source heat pumps). * The energy savings of heat pump installations in multi family houses were 50 per cent of pre-retrofit energy consumption (ground-source, rock-source and outdoor air-source heat pumps). * Expected temperature decreases in connection with some retrofits were not achieved. (22 figs., 84 tabs., 32 refs.).

28226 (CONF-9006117-1) **Radiant barrier field tests in army family housing units at Fort Benning, Georgia.** Levins, W.P.; Herron, D. Oak Ridge National Lab., TN (USA). [1990]. 30p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From Annual meeting of The American Society of Heating, Refrigerating and Air-Conditioning Engineers; St. Louis, MO (USA); 9-13 Jun 1990. Order Number DE90008755. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The US Army initiated a project to make measurements of heating and cooling energy in occupied Army housing units to determine the effect of radiant barriers (RBs) on energy consumption at Ft. Benning, in Columbus, GA. One side (1700 ft^2) of each of five duplexes was used as a control (no RB was installed in it) while the other side had perforated RB laid on top of the existing estimated R-11 fiberglass loose-fill attic insulation in the middle of July. The RBs were removed in the middle of January. All houses were instrumented with data logging equipment which measured air conditioner and gas furnace energy usages. Cooling season measurements showed that submetered air conditioner (A/C) KWh-meter data read on a weekly basis did not describe the performance of the RBs. Occupant lifestyle in general, and a dirty air filter at one site, nullified direct meter reading comparisons. Attic heat flow and temperature measurements revealed that the RBs were effective at all sites. Extensive regression analyses showed that savings were indeed obtained. Using the regression results with published temperature bin data for Ft. Benning gave estimated annual cooling savings from HRB use ranging from 253 to 1354 KWh, or from 3 to 17%. Heating energy usage did not appear to be affected by lifestyle as much as was cooling energy usage. HRBs gave an annual space heating savings of about 42 to 70 CCF of gas (11 to 19%) using averaged daily data to generate regression models. Measured emissivity values for samples of the horizontally mounted radiant barrier material showed essentially no change for the six-month period during which they were installed in the five test units. Although RBs were effective at Ft. Benning, it is recommended that more testing be done, especially in colder climates and in drier desert climates, before any general conclusions regarding the use of RBs in Army housing are formulated.

28227 (CONF-9006117-2) **Energy savings and performance of an improved energy efficiency measure selection technique.** Ternes, M.P. Oak Ridge National Lab., TN (USA). [1990]. 33p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From Annual meeting of The American Society of Heating, Refrigerating and Air-Conditioning Engineers; St. Louis, MO (USA); 9-13 Jun 1990. Order Number DE90008743. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A field test was performed in Buffalo, New York, to evaluate the performance of an energy efficiency measure selection technique for single-family houses. The design of this field test was based on a monitoring protocol developed for research projects sponsored by the US Department of Energy. The monitoring performed in following this protocol and the improved understanding of conservation measures obtained through analysis of the specified data are presented in this paper. Normalization of measured space heating energy consumption using indoor as well as outdoor temperature improved the quality of the final results because the basis for comparisons was improved and sources of variability were reduced. Space heating energy savings were 252 therms/years (26.6 GJ/year), which is 25% of pre-weatherization space heating energy consumption and 85% of predicted. Comparison of predicted to measured space heating energy savings were scattered just around a line of equivalency rather than appearing as a shotgun pattern, indicating that the selection technique was reasonably accurate in predicting savings for individual houses. A direct analysis of the indoor temperature data indicate that indoor temperatures changed about 0.5°F (0.3°C) after weatherization, although this small change may not be significant. 5 refs., 6 figs., 1 tab.

28228 (CONF-9006117-3) **Measured effects of dust on the performance of radiant barriers installed on top of attic insulation.** Levins, W.P. (Oak Ridge National Lab., TN (USA)); Hall, J.A. Oak Ridge National Lab., TN (USA). [1990]. 29p. Sponsored by U.S. DOE Conservation & Renewable Energy; Tennessee Valley Authority. DOE Contract AC05-84OR21400. From Annual meeting of The American Society of Heating, Refrigerating and Air-Conditioning Engineers; St. Louis, MO (USA); 9-13 Jun 1990. Order Number DE90008911. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The rate of dust accumulation and the effect of this dust accumulation on a horizontal radiant barrier (HRB) is of special interest because a HRB may perform better in both summer and winter than a truss radiant barrier (TRB), a HRB is much easier to install for retrofits in existing homes, and a HRB requires less radiant barrier (RB) material than a TRB. However, a HRB has two important potential disadvantages – condensation during winter which might cause structural damage and dust accumulation which could significantly degrade thermal performance. Results of a winter moisture field test have been reported previously by the authors of this paper. 16 refs., 10 figs., 10 tabs.

28229 (DOE/BP-1324) **Dealer participation in the Bonneville Power Administration manufactured housing Residential Construction Demonstration Project: Summary and**

findings. Onisko, S.A. USDOE Bonneville Power Administration, Portland, OR (USA). Office of Energy Resources. Jan 1990. 72p. Sponsored by U.S. DOE Management & Administration. Order Number DE90009375. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

A total of 8 regional manufacturers and 40 manufactured home dealers participated in the Bonneville Power Administration's (BPA) Residential Construction Demonstration Project (RCDP). The RCDP objective of marketing, manufacturing, and siting 150 homes built to Super GOOD CENTS (SGC) specifications to meet the region's Model Conservation Standards (MCS) was reached in April, 1989. To assess the dealer component of the project, a dealer exit survey was initiated in May, 1989, and completed in June, 1989. The Washington State Energy Office (WSEO) conducted the interviews, summarized the data, and provided magnetic and hardcopy documentation to BPA. Interviews were conducted by telephone with 39 of the 40 participating dealers (one dealer ceased business operations and could not be contacted). Questions were focused in three areas: set-up, marketing/selling, and general experience.

28230 (DOE/CE/26559–T1) **District cooling: Phase 2, Direct freeze ice slurry system testing: [Project status].** Winters, P.J. Chicago Bridge and Iron Technical Services Co., Plainfield, IL (USA). [1990]. 4p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-88CE26559. Order Number DE90009359. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The objectives of this research are to: extend the range of pressure drop data for ice-water slurry flows; and design and build a prototypical ice slurry distribution system which demonstrates ice slurry handling at an end user's heat exchanger, without sending ice slurry directly through the heat exchanger. Previous research (Phase 1) conducted by CBI under DOE Contract FG01-86CE26564 has shown a friction reducing effect of ice crystals in water flow. The results of this work demonstrated a 40% reduction in pump power required to move an ice-water slurry versus the same mass flow of water only. In addition to lower pressure drop, pumping ice slurries is advantageous because of the large latent and sensible heat cooling capacity stored in the ice compared to only sensible heat in chilled water. For example, an ice-water slurry with a 20% ice fraction (by mass) has a mass flow rate that is 70% less than the mass flow rate required for a chilled water system cooling and equivalent load. The greatly reduced mass flow combined with the friction reducing effects of ice-water slurries results in a total savings of 83% in pumping power. Therefore, a substantial savings potential exists for capital costs and system operating costs in ice-water slurry district cooling systems.

28231 (DOE/CE/26578–T2) **DOE grant for assessment of district cooling system for University of Arkansas for Medical Sciences, Little Rock, Arkansas.** Timmerman, R.W. (Timmerman (Robert W.) and Associates, Boston, MA (USA)); Broer, W.T.F. Arkansas Univ. for Medical Sciences, Little Rock, AR (USA); Goodman Engineers, Inc., Little Rock, AR (USA); Timmerman (Robert W.) and Associates, Boston, MA (USA); Broer (William T.F.) and Associates, Boston, MA (USA). [1990]. 132p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-88CE26578. Order Number DE90009057. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The object of this study which covers the assessment of the District Cooling Plant for the University of Arkansas for Medical Sciences (UAMS) Campus, was to study potential ways to use the newest technology in District Cooling and Methodology to optimize the efficiency of this plant. 11 figs.

28232 (DOE/CE/27475–T1) **Commercial building least-cost planning data development: Final report.** Yoder, R. Pacific Power and Light Co., Portland, OR (USA). Apr 1990. 123p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-87CE27475. Order Number DE90009480. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The eight buildings included in this study are all part of the Energy Edge project. Energy Edge encouraged construction of commercial buildings which were at least 30% more efficient than if they had been built to Model Conservation Standards. Bonneville Power Administration funding for the Energy Edge included paying for incremental design and construction costs, end-use monitoring, and several research studies. The results of the research are forthcoming. In a sense the Energy Edge buildings chosen for this study have been idealized through the modeling process. Measures which were not installed or did not function according to design specifications, were either assumed to perform according to design specifications or eliminated from the LCUP model. The full modeling protocol is included in the Appendix at the end of this report. Section 2 discusses some of the modeling issues that came up in the course of this LCUP study. The costs presented here should be used with caution. The lack of consistency in contractors' reporting methods makes it difficult to use the cost data as it now stands. Bonneville is currently funding a study to standardize cost data for all Energy Edge buildings. 135 figs., 32 tabs.

28233 (DOE/SF/17714–T2) **DOE [Department of Energy] San Francisco annual report.** Ackco, Inc., Boulder, CO (USA). 10 Apr 1990. 25p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-88SF17714. Order Number DE90009366. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This annual report focuses on the twenty subgrantees that were monitored by ACKCO, Inc. from September 30, 1988 to September 29, 1990. In the following analysis, ACKCO, Inc. will proceed from the general to the specific; that is from: generic findings (weaknesses) among the 15 subgrantees; to summary of findings by State at the subgrantee level; to recommendation for technical assistance by Region and State; to price analysis of weatherization materials purchased by region, State and subgrantee.

28234 (EPRI-CU–6813) **A proposed methodology for rating integrated air-source heat pumps: Final report.** Dougherty, B.P. (National Inst. of Standards and Technology (NEL), Gaithersburg, MD (USA). Building Environment Div.). Electric Power Research Inst., Palo Alto, CA (USA); National Inst. of Standards and Technology (NEL), Gaithersburg, MD (USA). Building Environment Div. c Apr 1990. 92p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

At the National Institute of Standards and Technology (NIST), work is on-going to develop a proposed procedure for testing and rating air-source heat pumps that heat, cool, and provide domestic water heating. The family of appliances providing these three functions are referred to here as integrated (or combined) heat pump/water heating appliances. For these appliances, the heat pump contributes to heating the water in a storage-type water heater through the use of a refrigerant-to-potable water heat exchanger. The laboratory testing, the calculation procedure, and the method for reporting performance are described. The testing is an adaption of the laboratory tests conducted when rating conventional heat pumps and water heaters. Seasonal estimates of energy consumption rates are calculated using a bin type approach. Combined performance factors and operating costs are used for reporting performance. 32 refs., 7 figs., 11 tabs.

28235 (IBP-WB–18/1987) **Passive utilization of solar energy in owner-occupied private homes - results of measurements and energy analysis of the solar house in Landstuhl.** IRB-Forschungsbericht. Reiss, J.; Erhorn, H.; Kuhl, W.; Oswald, D.; Steinborn, F. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 9 Nov 1987. 44p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

22 so-called solar houses built according to the principles of energy saving and three conventionally built reference houses were subjected to detailed measurement in order to show how modern heating technology can be implemented in private homes. This report contains the results of the energy assessment of the solar house in Landstuhl. The gross consumption of heating energy lies about 40% beneath the average German values. The living room temperatures with adjoining winter garden and temporary sunshade remain below the outside temperatures in the summer. The Southern rooms which have no sunshades have higher room temperatures. The occupants remit a more-than-average amount of

heat which contributes to the heating of the room. The temporary sun shades influence the energy consumption noticeably. The wintergarden reduces the heat consumption only slightly. The heating system shows an average efficiency. (BWI) With 4 tabs., 12 figs.

28236 (IBP-WB–20/1987) **Passive utilization of solar energy in owner-occupied private homes - results of measurements and energy analysis of the solar house in Homburg.** IRB-Forschungsbericht. Reiss, J.; Erhorn, H.; Kuhl, W.; Oswald, D.; Steinborn, F. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 30 Nov 1987. 43p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

22 so-called solar houses built according to the principles of energy-saving and three conventionally built reference houses were subjected to detailed measurements. This report contains the results of the energy assessment in Homburg. The gross consumption of heating energy remains 33% beneath the German average. In the rooms facing south which have sunshade the air temperatures are only slightly higher than the temperatures outside. The winter garden's contribution to the reducing of heating energy consumption is very small. Heating the wintergarden (to keep frost at bay) used up much the more energy than can be saved for the house by the wintergarden, the overall efficiency of the heating system is low. (BWI) With 4 tabs., 12 figs.

28237 (IBP-WB–21/1987) **Passive utilization of solar energy in owner-occupied private homes - results of measurements and energy analysis of the solar house in Holzkirchen.** IRB-Forschungsbericht. Oswald, D.; Erhorn, H.; Kuhl, W.; Reiss, J.; Steinborn, F. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 10 Dec 1987. 40p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

22 so-called solar houses built according to the principle of energy-saving were set up in order to demonstrate how modern heating technology can be implemented in private homes. These houses and 3 conventionally built reference houses were subjected to detailed measurements. This report contains the results of the energy evaluation of a solar house near Holzkirchen. Gross consumption of heating energy remains 50% beneath the German average value. Built-in protection against insulation avoids overheating in the summer. There is a hot-water floor heating system and an additional electric heating system which operate separately. (BWI) With 4 tabs., 12 figs.

28238 (IBP-WB–22/1987) **Passive utilization of solar energy in owner-occupied private homes - results of measurements and energy analysis of the conventionally built reference house near Holzkirchen.** IRB-Forschungsbericht. Oswald, D.; Erhorn, H.; Kuhl, W.; Reiss, J.; Steinborn, F. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 15 Dec 1987. 38p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

22 so-called solar houses, built according to the principle of energy-saving and 3 conventionally built reference houses were subjected to detailed measurements in order to demonstrate how modern heating engineering can be implemented in private homes. This report contains the results of the energy assessment of the conventionally built house near Holzkirchen. The gross consumption of heating energy in this building is about 55% lower than the German average. The heating system is an electric direct heating system with thermostat-controlled heaters. (BWI) With 4 tabs., 12 figs.

28239 (IBP-WB–24/1988) **Passive utilization of solar energy in owner-occupied private homes - results of measurements and energy analysis of the solar house in Waldmoor.** IRB-Forschungsbericht. Reiss, J.; Erhorn, H.; Kuhl, W.; Oswald, D.; Steinborn, F. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 11 Feb 1988. 41p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

22 so-called solar houses, built according for the principle of energy saving and three conventionally built reference houses were subjected to detailed measurements in order to show how modern heating technology is implemented in private homes. This report contains the results of the energy evaluation of the solar house in Waldmohr. The gross consumption of heating energy of the building remains about 55% beneath the German average. The solar protection measures and natural shade provided by trees keeps the room temperature in the building and in the wintergarden lower than the temperature outside. (BWI) With 4 tabs., 12 figs.

28240 (IBP-WB–25/1988) **Passive utilization of solar energy in owner-occupied private houses - results of measurements and energy analysis of five solar houses with identical floor plans in Landstuhl.** IRB-Forschungsbericht. Oswald, D.; Erhorn, H.; Kuhl, W.; Reiss, J.; Steinborn, F. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 18 Feb 1988. 49p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

22 solar houses, designed according to the principle of energy-saving construction and 3 conventionally built reference houses are subjected to detailed measurements in order to demonstrate how modern heating technology can be used in private homes. This report contains the results of the energy assessment of five solar houses with identical floor plans. The gross consumption of heating energy in these buildings was about 7% lower than the German average. Sun protection measures are effective. The utilization of solar energy is very much limited by the occupants' living habits. Temporary thermal insulation has a noticeable influence on the energy demand. Reducing the window size on the south side to one third would slightly increase the heating energy consumption. The storage effect of floor and ceilings with extra-thick pavements was negligible. (BWI) With 8 tabs., 14 figs.

28241 (IBP-WB–26/1988) **Passive utilization of solar energy in owner-occupied private homes - results of measurements and energy analysis of three solar houses in Landstuhl with identical floor plans.** IRB-Forschungsbericht. Oswald, D.; Erhorn, H.; Kuhl, W.; Reiss, J.; Steinborn, F. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 22 Feb 1988. 56p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

22 so-called solar houses, built according to the principle of energy saving and three conventionally built reference houses were subjected to detailed measurements in order to demonstrate how modern heating technology can be used in private homes. This report contains the results of the energy assessment of the three solar houses in Landstuhl whose floor plan is identical. The gross consumption of heating energy is 46% lower than the German average. In the South rooms the room temperature does not exceed outside temperatures in the summer provided that the sun shades are used. The houses are heated by a gas-heated directly-fired hot air generator. Hot water is provided by a hot-water storage tank heated with a solar collector. Waste air from toilet and bathroom is recovered and channelled to a heat recovery system. Efficiency is 60%. (BWI) With 6 tabs., 15 figs.

28242 (IBP-WB–28/1988) **Passive utilization of solar energy in owner-occupied private homes - results of measurements and energy analysis of the solar house in Altenstadt.** IRB-Forschungsbericht. Oswald, D.; Erhorn, H.; Kuhl, W.; Reiss, J.; Steinborn, F. Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima;

Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 17 Mar 1988. 39p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

22 solar houses, built according to the principle of saving energy and 3 conventionally built houses were subjected to detailed measurements in order to show how modern heating technology can be used in private houses. This report contains the results of the energy assessment of the solar house in Altenstadt. The gross consumption of heating energy is 58% lower than the german average. Shade provided by the projecting roof and the large storage capacity of the inner building components provide effective protections against the summer heat. An electrically heated storage unit supplies thermal energy to the heating systems. Water is heating with an air-to-water heat pump which is combined with a storage limit. (BWI) With 4 tabs., 12 figs.

28243 (IBP-WB–29/1988) **Passive utilization of solar energy in owner-occupied private homes - results of measurements and energy analysis of the solar house in Issum.** IRB-Forschungsbericht. Reiss, J.; Erhorn, H.; Kuhl, W.; Oswald, D.; Steinborn, F. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 14 Apr 1988. 46p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

22-so-called solar houses built according to the principle of energy saving and three conventionally built reference houses were subjected to detailed measurements. The results of the energy analyses of the solar house in Issum are described in this report. Gross consumption of heating energy remains about 75% beneath the German average value. Due to sunshades the living room temperatures in the summer remain below outside temperature. The heat recovery system contributes effectively to the reduction of ventilation heat losses. The transparent blinds on the southern side are not efficient during the day because the reduced solar gains are larger than the prevented transmission heat losses. The newly developed window system shows very good results. (BWI) With 4 tabs., 12 figs.

28244 (IBP-WB–30/1988) **Passive utilization of solar energy in owner-occupied private homes - results of measurements and energy analysis of the solar house in Ingelheim.** IRB-Forschungsbericht. Oswald, D.; Erhorn, H.; Kuhl, W.; Reiss, J.; Steinborn, F. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 20 Apr 1988. 38p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

22 so-called solar houses, designed according to the principle of energy-saving construction and 3 conventionally built reference houses were subjected to detailed measurements in order to demonstrate how modern heating technology can be used for private homes. This report contains the results of the energy assessment of the solar house in Ingelheim. The gross consumption of heating energy is about 44% lower than the German average. Shade provided by projecting eaves gives good protection against heat. The wintergarden does not save energy as it is heated. Considerable energy savings would be possible if the house had thermopane windows. The heating system has an overproportionally high efficiency. (BWI) With 4 tabs., 12 figs.

28245 (IBP-WB–31/1988) **Passive utilization of solar energy in owner-occupied private homes - results of measurements and energy analysis of the solar house in Woellstein.** IRB-Forschungsbericht. Reiss, J.; Erhorn, H.; Kuhl, W.; Oswald, D.; Steinborn, F. Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 3 May 1988. 41p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

22 solar houses designed according to the principle of energy-saving construction and 3 conventionally built reference houses were subjected to detailed measurements in order to demonstrate how modern heating technology can be used in private houses. This report contains the results of the energy assessment of the solar house in Woellstein. The gross consumption of heating energy is about 63% lower than the German average. Sun protection measures can be regarded as sufficient. Heat is generated with an outer-wall gas heater and a wood-fired stove in the living room. (BWI) With 4 tabs., 12 figs.

28246 (IBP-WB–32/1988) **Passive utilization of solar energy in owner-occupied private homes - results of measurements and energy analysis of the conventional reference house in Zirndorf.** IRB-Forschungsbericht. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Informationszentrum Raum und Bau der Fraunhofer-Gesellschaft (IRB), Stuttgart (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 30 May 1988. 39p. (In German). Contract BMFT 03E-4339-C. Available from Copy held by UB/TIB Hannover.

The aim of a demonstration project which is subsidised by the Federal Ministry for Research and Technology is to show how the consumption of heating energy in private households can be reduced by means of modern technology and building concepts which are available on the market. 22 solar houses, built according to energy-saving construction principles and 3 conventional reference houses were subjected to detailed measurements. This report contains the results of measurements carried out in the conventionally built reference house in Zirndorf-Weiherhof. (orig./KW) With 4 tabs., 12 figs.

28247 (IKE–7-14) **Determination and validation of the energy consumption of heating and HVAC systems by means of computer-controlled operational simulation. German contribution to IEA Annex 10.** Ast, H.; Bach, H.; Stephan, W. Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme. Nov 1988. 271p. (In German). Contract BMFT 03E-8163-A. Order Number DE90780120. Available from NTIS (US Sales Only), PC A12/MF A01.

This project is the contribution of Germany to the program of the International Energy Agency (IEA) energy conservation in buildings, IEA-annex 10 'System Simulation'. Component specifications for every HVAC-component are documented and tested. The energetic evaluation of HVAC-system needs an evaluation method. For this purpose the 'degree of utilisation theory' is extended. The simulation programs and evaluation methods are used in various parametric studies. The results of this studies are used to find rules for sizing, operating and optimizing of HVAC-systems and buildings. (orig.).

28248 (K/D–5834) **A test program to determine the structural properties of unreinforced hollow clay tile masonry walls at the DOE Oak Ridge plants.** Fricke, K.E.; Jones, W.D. Oak Ridge Gaseous Diffusion Plant, TN (USA). 20 Nov 1989. 12p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. (CONF-900673–1: 5. North American masonry conference, Urbana, IL (USA), 3-6 Jun 1990). Order Number DE90003518. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A recent Department of Energy (DOE) "General Design Criteria" has emphasized the importance of determining the adequacy and safety of both new and existing facilities to natural phenomenon hazards. Many of the buildings at the DOE Oak Ridge facilities are constructed with unreinforced masonry hollow clay tile infill walls – in some cases these walls comprise a substantial part of the lateral force resistance for a building. In order to perform a realistic assessment of the strength of the buildings to seismic events it is important to accurately predict the behavior of these walls. Very little information is currently available on hollow clay tile masonry, its structural properties and behavior. As the in-situ condition of these walls throughout the plants is suspect due to their age and exposure to numerous chemicals, a test program was initiated at the Oak Ridge plants to obtain material properties for use in the natural phenomena hazards analysis. This paper presents the preliminary results of that testing program. The following tests on clay-tile walls, units, and panels were performed: (1) in-situ mortar bed shear strength, (2) compression strength, (3) splitting tensile strength, and (4) diagonal tension (shear) strength of panels which

had been removed from existing walls. The testing program is ongoing, is being expanded, and will include not only in-plane tests, but out-of-plane bending testing as well. 11 refs., 3 figs., 5 tabs.

28249 (KTM/E-D–180) **Optimization of a heat pump plant with a computer program.** Junttila, V. (Teollisuussuunnittelu Oy, Helsinki (Finland)). Kauppa- ja Teollisuusministerio, Helsinki (Finland). Energiaosasto. 1989. 128p. (In Finnish). Project KTM-116/881/85. Order Number DE90770760. Available from NTIS (US Sales Only), PC A07/MF A01.

The goal of the project was to develop a computer program which could be used for selecting, dimensioning and optimizing different heat pump plants. Existing programs were analysed. A program which was originally developed in Chalmers Univesity of Technology in Sweden was choosed for development work. Many new subroutines were made to the program. The Heat Pump program was made more userfriendly and it was documented properly. The developed Heat Pump program gives an impartial tool for designers and decision makers. With this computer program the quality of the design work can be improved and a lot of time, trouble and money can be saved. The computer program can also be used to test the reliability of the plans and calculations of the suppliers and other impartial interest groups connected to a heat pump project. The structure of the program is flexible so that new technical components can be added to the program. Results from the technical simulation calculations can be used in the economical part of the program so that payback period, annual worth, internal rate of return and net present value can be calculated. The report includes also a short document of a program named OPTIMI which was made before any good existing program could be found for the development work. After the program from Chalmers was found and choosed for development work it was not possible nor reasonable to develop the totally own program very thoroughly.

28250 (NBES–101) **Passive solar addition: Final report.** Misener, A. New Brunswick Energy Secretariat, Fredericton, NB (Canada). [1989]. 19p. (CE–02896). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The paper describes a 300 square foot passive solar addition heat to an existing house. The project was sponsored partially by the Conservation and Renewable Energy Demonstration Program (CREDA), and its objectives were to demonstrate the application of a 35 million BTU solar retrofit, to determine its economic feasibility, and to monitor the environment inside the house after the retrofit was complete. The existing house became the sink for the solar heat. Triple glazed windows were installed without condensation problems. A large window area was found to be aesthetically pleasing. It was found that the payback period was 9.5 years based on incoming radiation, and 12.8 years based on difference in electrical heating requirements. The need for supplementary heat was minimal. 8 refs,. 7 figs.

28251 (ORNL/FTR–3587) **[Field monitoring of buildings and related systems]: Foreign trip report, April 1, 1990–April 5, 1990.** Harrje, D.T. Oak Ridge National Lab., TN (USA). 11 Apr 1990. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90009819. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The International Energy Agency Conference was held at Chalmers University of Technology in Gothenburg, Sweden, April 1–5, 1990. This conference was a joint undertaking of three IEA committees, Energy Conservation in Building and Community Systems, Solar Research and Development and CADDET. The common goals of these three groups in the area of field monitoring were explored by 50 experts from 10 IEA countries. The format was based upon eight invited keynote papers reviewing the various aspects of field monitoring, a series of complementary presentations and demonstrations, and deliberations by three working groups. The working group agenda was directed to supply guidance for future IEA projects. The criteria for evaluation included: projects should be planned and executed to provide reliable results while including data necessary for general project assessments; results should be based upon the use of recognized and validated techniques; results should be presented to achieve the desired impact on the key audiences; and the true costs and other limiting factors of field monitoring projects should be recognized. The traveler presented one of the keynote papers, was chairperson of working group A, presented three related papers and served as secretary to the conference chairperson for the final summary session.

28252 (ORNL/Sub–88-SD731/1) **Fabrication, evaluation, and application of evacuated panel insulation (EPI) to portable coolers.** Barito, R.W. (Barito (R.W.) and Associates, Inc., Louisville, KY (USA)); Barito, M.O.; Kollie, T.G.; McElroy, D.L.; Weaver, F.J.; Werst, S.H.; Chu, W.; Childs, K.W.; Fine, H.A.; Landrum, H.L. Jr. Oak Ridge National Lab., TN (USA); Barito (R.W.) and Associates, Inc., Louisville, KY (USA). Mar 1990. 32p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE90010158. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Thermal insulation is a key parameter in the national energy equation. A reduction in energy usage was realized when chlorofluorocarbon (CFC) blown foams were utilized in thermal insulation applications; however, the discovery that CFC's are reducing the stratospheric ozone resulted in an international agreement to restrict the future production of CFC's. If viable alternatives are not developed, these restrictions will result in increased energy demands. One alternative to foams containing CFC is carbon dioxide blown foams used in a composite insulation system with evacuated panel insulation (EPI). Carbon dioxide blown foams are about 33% higher in thermal conductivity than CFC blown foams; however, EPI's are about 66% lower in conductivity than CFC blown foams. By combining these two insulations into one composite insulation system, CFC's can be eliminated and replaced by a system with lower thermal conductivity. This report covers the fabrication and evaluation of EPI's and their application in a composite panel/CFC foam insulation system in portable ice coolers. Ice coolers were used as a demonstration device because they provided a simple tool for determining the resistances of the composite insulation as compared with the foam alone. CFC foams were used as this project involved a "drop-in" replacement in a production environment where substitution of CO_2 foam was not practical. 16 refs., 3 figs., 9 tabs.

28253 (PB–90-161563/XAB) **Gas heating in high-rise office buildings. Topical report, September 1987-March 1988.** Gretsinger, K.M. American Gas Association Labs., Cleveland, OH (USA). Apr 1988. 82p. Available from NTIS, PC A05/MF A01.

Technical and economic issues are addressed in detail regarding gas heating applications of high-rise office buildings (over 3 floors and 10,000 sq ft per floor), which typically use Variable Air Volume (VAV). Advanced technologies are described and show a consorted effort by utilities, consultants, and equipment manufacturers to offer building owners an option to rising electric demand costs. Hybrid (gas and electric) heating systems are emphasized since many studies, based on life-cycle economics, have shown favorable payback periods of less than three years.

28254 (PB–90-166091/XAB) **Cogeneration and gas-cooling research status report, 1984-85.** Gas Research Inst., Chicago, IL (USA). Sep 1985. 137p. (GRI–85/7008). Available from NTIS, PC A07/MF A01.

See also PB–88-130265.

The 1984-1985 status report discusses activities within GRI's Residential/Commercial Energy Systems (RCES) subprogram. The funding rationale, goals and objectives, accomplishments, strategy, and contract status are described for each project within these project areas: Commercial Heating and Cooling Systems, Fuel Cell Systems, and Energy Cogeneration Systems.

28255 (PB–90-167263/XAB) **Heat Pump and Appliance Research: Research status report 1985-1986.** Gas Research Inst., Chicago, IL (USA). Sep 1986. 136p. (GRI–86/7017). Available from NTIS, PC A07/MF A01.

See also PB–88-250576.

The status report provides information on activities within GRI's Heat Pump and Appliance Research Department during 1985-1986. The objectives and goals, accomplishments, strategies, and

contract status are described for these project areas: Residential heating and cooling systems, Residential heat pumps and prime movers, Commercial heat pumps and prime movers, Residential appliances, Commercial appliances, and Building systems.

28256 (PB–90-167644/XAB) **Industrial Utilization research and development status report: 1985-1986.** Gas Research Inst., Chicago, IL (USA). Sep 1986. 166p. (GRI–86/7018). Available from NTIS, PC A08/MF A01.

See also PB–89-136196.

The status report contains summaries of over 40 projects within GRI's Industrial Utilization subprogram during May 1985-May 1986. Project and contract status summaries are provided for the project areas: Industrial energy systems, Advanced heat transfer, Burner systems development, Metals industrial processes, Nonmetals industrial processes, and Industrial materials and components.

28257 (PB–90-169525/XAB) **Heat Pump and Appliance Research: Status report 1984-1985.** Gas Research Inst., Chicago, IL (USA). Sep 1985. 164p. (GRI–85/7005). Available from NTIS, PC A08/MF A01.

See also PB–88-102462.

The 1984-1985 status report discusses activities within Gas Research Institute (GRI's) Heat Pump and Appliance Research subprograms. The project area basis, objectives and goals, accomplishments, strategies, and contract status are described for projects within these project areas: Residential heating and cooling systems, Residential heat pumps and prime movers, Commercial heat pumps and prime movers, Residential appliances, Commercial appliances, and Building systems.

28258 (PB–90-169533/XAB) **Industrial Utilization research and development status report: 1984-1985.** Gas Research Inst., Chicago, IL (USA). Jul 1985. 146p. Available from NTIS, PC A07/MF A01.

See also PB–88-160338.

The 1984-1985 status report discusses activities within GRI's Industrial Utilization Subprogram. The objective and goals, accomplishments, strategies, and contract status are described for each project within these project areas: Industrial energy systems, Advanced heat transfer systems, Burner systems development, Metals industrial processes, and Nonmetals industrial processes.

28259 (PB–90-169541/XAB) **Industrial Utilization research and development. status report, July 1983 to July 1984.** Gas Research Inst., Chicago, IL (USA). Jul 1984. 125p. (GRI–84/7015). Available from NTIS, PC A06/MF A01.

Information on the status (1983-1984) of activities within GRI's Industrial Utilization subprogram is provided. The technical objectives, research strategies, goals, accomplishments, and contract status are described for these project areas: Industrial energy systems, Energy recovery systems, Burner systems development, Metals industrial processes, and Nonmetals industrial processes.

28260 (PB–90-171232/XAB) **Integrated gas-fired desiccant dehumidification vapor-compression cooling system for residential application. Phase 2. Final report, December 1987-December 1988.** Bartz, D.; Zografos, A.; Marsala, J. TECOGEN, Inc., Waltham, MA (USA). Oct 1989. 211p. (TR–4477-142-89). Available from NTIS, PC A10/MF A02.

See also PB–89-140842.

Field tests of a residential liquid-desiccant dehumidifier are described. From analysis done in Phase I of this program, a gas-fired boiler for regenerating the desiccant was selected with a one-ton capacity dehumidifier. Three field-experiment units were built. One was installed at a test house in Gaithersburg, Maryland owned by GEOMET Technologies. The second was installed in Atlanta, Georgia, supported by the Atlanta Gas Light Company. The third unit was shipped to Lone Star Gas Company, Forth Worth, Texas, to be installed in 1989. Once startup problems were corrected, the units ran reliably, controlling indoor humidity accurately. The seasonal COP for the Gaithersburg installation was 0.58; for Atlanta the COP was 0.50. By extending the operating periods (typically 5 minutes in these tests), the COP should increase. A manufacturing cost study of the residential dehumidifier showed that a factory cost of $553.62/unit is achieved at 50,000 units/year volume.

28261 (SCC–25(81-66)) **Energy efficient retrofit.** Laing, B. (Sunshine Country Construction, New Bothwell, MB (Canada)). Manitoba Dept. of Energy and Mines, Winnipeg, MB (Canada). Conservation and Renewable Energy Branch; Sunshine Country Construction, New Bothwell, MB (Canada). [1990]. 26p. (CE–02886). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The paper describes the retrofitting of modern energy conservation techniques and equipment to an older energy inefficient home in Manitoba. The project received funding under Canada's Conservation and Renewable Energy Demonstration Agreement (CREDA), and was undertaken to demonstrate the advantages of retrofitting older rural homes. The home was expanded from 87.2 to 258 squares metres of heated living space. Double wall construction, increased insulation, continuous air vapour barrier, triple-glazed windows with maximum glazing on the south side, and an air-to-air heat exhanger were among the features added. Analysis indicated that the normalized annual heating load was reduced by 50%, even though the living area had nearly tripled. By area, the heat load was reduced by 80%, from 256 to 43 kWh/square metre/year. Payback for similar retrofits is estimated at between 10 and 21 years, depending on the size and pre-retrofit condition of the house. 5 figs., 6 tabs.

28262 (STEV-FJV–90-1) **Analysis of consumer substations in district heating systems.** Gummerus, P. (Chalmers Univ. of Tech., Goeteborg (Sweden). Dept. of Energy Conversion). Statens Energiverk, Stockholm (Sweden); Chalmers Univ. of Tech., Goeteborg (Sweden). Dept. of Energy Conversion. Oct 1989. 95p. (In Swedish). Project STEV-656-043. (CTH-IE-A–88-174). Order Number DE90770854. Available from NTIS (US Sales Only), PC A05/MF A01.

The study deals with the establishment of criteria for estimating the performance of consumer substations and their load following ability. A method of establishing a standard load has also been developed. Using the criteria and the standard load, an analysis of consumer substations has then been undertaken. The analysis has been carried out with the help of computer simulation. The method for evaluating thermal performance takes account of the non-linear characteristics and the dynamics of the consumer substation, the wide range of loads it is subjected to over a year, and the rapid changes in load caused by the stochastic nature of the use of hot tap-water. With the method developed, fair comparisons between different principles of configuration can be made, various adjustments can be carried out, and different dimensioning principles for these can be used. This is made possible because the models of the consumer substations can be subjected to identical loads and the surrounding circumstances can be arbitrarily changed, which is not the case with an experimental approach. Results from the analysis show that the consumer substations, as they are today, are robust. That a consumer substation is robust means that its thermal performance do not vary with changes in adjustment, but depend mainly on the dimensioning. The most efficient connection principle is the three-stage connection. The study shows that the level of performance is closely related to the surface size of the radiator. As a consequence of the robustness of the consumer substation, a satisfactory regulation of the hot tap-water temperature can be achieved by a rough adjustment of the regulators. (22 figs., 29 tabs., 19 refs.).

28263 (SV-UL–89-52) **Efficient electric systems in small houses.** Kristiansson, Peter. Swedish State Power Board, Vaellingby (Sweden). 2 Nov 1989. 31p. (In Swedish). Order Number DE90770784. Available from NTIS (US Sales Only), PC A03/MF A01.

The possibilities for electric energy conservation in one-family houses are investigated. Data from three communities (Tierp, Vaennaes and Kalix) have been analyzed. The following areas are discussed: converson of the heating system, load management, ventilation, indoor temperature, dimensioning of electric heating systems, appliances, and already applied conservation measures. A general conclusion is that several possibilities for conservation of electric energy exist in the houses studied. The most critical function is the ventilation system.

28264 (SV-UL–1989-39) **Yearly energy flow through windows and over-all coefficient of heat transfer for windows with plastic sheetings and low-emitting coatings.** Merkell, A.L. Swedish State Power Board, Vaellingby (Sweden). 4 Oct 1989. 41p. (In Swedish). Order Number DE90770779. Available from NTIS (US Sales Only), PC A03/MF A01.

A very simply usable model for estimation of the yearly energy transport through windows was developed. Exchange from double to triple-glazed windows at Aelvkarleby results in a yearly net gain of 54 kWh/m^2 towards south and of 97 kWh/m^2 towards north. A hotbox for measurement of over-all heat transfer coefficients of glazing. The heat transfer coefficient and solar transmission was measured for various windows. If the inner pare in a double-glazed window is replaced by low-emitting glass and a plastic sheet is inserted between the pares the over-all heat transfer coefficient will be lowered from 2.8 to 1.2 W/m^2, K. On the other hand the sheet only yields a marginal improvement when inserted in a window with ordinary high-emitting glazing. (52 figs., 13 refs.).

28265 (SV-UL–1989-56) **Field test of direct expansion ground-source heat pumps for heating and cooling applications in single family homes: Final report.** Spante, L. Swedish State Power Board, Vaellingby (Sweden). 21 Nov 1989. 18p. Order Number DE90770781. Available from NTIS (US Sales Only), PC A03/MF A01.

Ontario Hydro (OH) Canada, Swedish State Power Board (SSPB) and SwedPower (SwP) Sweden have jointly tested a heat pump application with direct evaporation in vertical bore holes. The heat pumps are desinged for both heating and cooling and are applicable to single family homes. The co-operative project between OH, SSPB and SwP was started during 1987. Three heat pumps were installed in Sweden (February 1988) and one in Canada (December 1987) in single family homes. A detailed monitoring program has been applied to the test sites. The heat pump refrigerant circuit is connected to copper pipes inserted in the bore hole. The refrigerant evaporates inside the pipes during operation in heating mode and condenses in the pipes in cooling mode. There are two separate coils in the bore hole, one coil for cooling and one for heating. The direct expansion ground source heat pump (DXHP) has shown satisfactory performance in heating mode with a Seasonal Performance Factor about 2.2. The measured annual electricity saving during the heating season 1988/89 was between 26-42% of the heating and DHW demand. More experience and research work is necessary to obtain optimal desing of the DXHP cooling application. In Sweden only a small fraction of the single family house stock with large heating demand constitute a possible market for the DXHP-system at present.

28266 (SV-UL–1989-58) **Air/air source heat pumps in electrically heated houses: Saving and operating results with four heat pumps at Tierp.** Arnell, G. Swedish State Power Board, Vaellingby (Sweden). 23 Nov 1989. 39p. (In Swedish). Order Number DE90770778. Available from NTIS (US Sales Only), PC A03/MF A01.

To evaluate the possibilities of electricity saving with this type of heat pumps tests were done with four different heat pumps located in four houses, two 1-storey and two 1.5-storey houses with open planing. In the house where the greatest saving was attained the electricity consumption could be decreased by 4600 kWh (33%) from 14000 to 9600 kWh/year. The decrease corresponds to 80% of the theoretically maximal saving which in this case was estimated to 5700 kWh/year. In the remaining three houses the saving was respectively 11, 20 and 36 % of the heating requirement. This corresponds to 33, 47 and 73% of what is theoretically possible. The reason for the theoretical saving not being attained is mainly that the hot air given off from the heat pumps condensa is not effectively distributed in the house. The results are consequently less dependant on the heat pump itself than on where in the house it is installed and on the house planning. (32 figs., 7 tabs.).

28267 (TKK-KO/LVI–B25) **An impact of the use of return air on comfort and health of employees in an office building.** Komulainen, K.; Tuomaala, P.; Majanen, A.; Jaakola, J. Helsinki Univ. of Technology, Otaniemi (Finland). Lab. of Heating, Ventilation and Air Conditioning. 1989. 113p. (In Finnish). Order Number DE90770759. Available from NTIS (US Sales Only), PC A06/MF A01.

An impact of the use of the return air on comfort and health of the employees in an office building and on the building's energy consumption were the objectives of the project. A questionnaire method was used to determine an impact of the return air on health and comfort. Influence of the return air on energy consumption in the building was determined with measurements. The statistical analysis of the measurements conducted in the heating season 1987/1988, the results of the questionnaire study and the building data are presented in this report. Based on the analysis of the questionnaire responses, no statistically significant relation was found between the magnitude of the return air fraction in supply air and the perceived comfort parameters. However, had the return air fraction been 57% of supply air, the employees reported the room air being more dusty when compared with the situation at return air fraction 17%. Also the smell of tobacco smoke was perceived more often. The number of employees satisfied with the air humidity was only slightly higher at the return air fraction 57% than at the 17%. The impact of the magnitude of the return air fraction in supply air on comfort was studied simultaneously in two identical office buildings. In one building the return air fraction was maintained constant at 57% and in the other it was increased from 17% to 57%. In general, the change of the return air fraction from 17% to 57% increased the number of dissatisfied but not significiantly in the statistical sense. However, the growth of the number of dissatisfied with certain comfort parameters, e.g. thermal environment and air exchange suffiency, was statistically significant. The field measurements showed that the use of the return air had a remarkable impact on the energy consumption by the air-conditioning system.

28268 (TTKK-RT–1989/1) **The profitability of energy conservation measures by building types.** Heljo, J. Tampere Univ. of Technology (Finland). Construction Economics. 1989. 43p. (In Finnish). Project KTM-122/881/82. Order Number DE90770761. Available from NTIS (US Sales Only), PC A03/MF A01.

The main goal of the study called "The profitability of energy conservation measures" was to update the profitability estimates for energy conservation measures. The calculations were made and the results were presented for building types that represent the actual building stock and new construction well. The aim was to revise the tables of the SITRA (Finnish National Fund for Research and Development) thermal economy study from 1977 on the profitability of conservation measures. Only those measures were included whose profitability is uncertain (e.g. ventilation air heat recovery and adding extra insulation to the outer wall). With regard to clearly economic and uneconomic measures the situation remains much the same as indicated in the SITRA study. The profitability estimates for various building types at different energy prices were only indicative. Thus the profitability of measures should be determined case by case since it is of little use to the individual builder to be told that the measure he carried out is, on the average, profitable, but, in his case, clearly unprofitable. On the other hand, he may have dropped a measure that clearly would have been profitable to him only because it was generally claimed to be unprofitable. A common error in calculating profitabilities is the mixing up of energy conservation and building maintenance measures. If, for example, a decision is made to renovate the cladding of a building due to its bad condition, the costs should not be included in the cost of providing additional thermal insulation. The study carried out showed that there are a lot of buildings in Finland to which it would be highly profitable to apply measures deemed unprofitable in public discussion. The problem lies in the fact that case by case profitability estimates are laborious and often require that an expert visit the building site.

28269 (VTT-TIED–970) **Local blow and radiator heating in work site ventilation.** Enbom, S. (Valtion teknillinen tutkimuskeskus, Tampere (Finland). Turvallisuustekniikan laboratorio). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Apr 1989. 45p. (In Finnish). Order Number DE90770747. Available from NTIS (US Sales Only), PC A03/MF A01.

The study examines how the low velocity air flow of a local blow depends on the air flow and on the temperature difference between the incoming air and indoor air. The airflow of local blow is directed

from top to bottom. Velocity development of the incoming air in the flow direction is studied by measurements. A local blow system can protect an employee working below the system from impurities, which have migrated from the surroundings to the work site. Also impurities born in work sites are examined espicially welding impurities. Also the influence of a local blow to an employee's thermoinal working conditions and thermal comfort is studied. The cooling influence of a local blow can be eliminated by radiator heating.

28270 (VTT-TIED–1022) **Large rock caverns: Heat loss analysis of rock caverns.** Vaeaetaeinen, A. (Valtion teknillinen tutkimuskeskus, Espoo (Finland). Geotekniikan laboratorio); Ritola, J. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Jul 1989. 65p. (In Finnish). Order Number DE90770745. Available from NTIS (US Sales Only), PC A04/MF A01.

Average heat losses conducted during a calculation period of five years from a rock cavern heated to a temperature of 14-28 deg C were determined using an element method. The widths of the analyzed caverns varied between 8 and 24 metres and their roof thicknesses between 7 and 15 metres. The results agree well with the results obtained in the studied of thermal losses and heat consumption in the Otaniemi rock caverns in 1983-1986. The instantaneous peak values of the average heat losses were found to be 4-13 W/m^2 depending on the size, depth and inside temperature of the cavern. Those peak values decrease rapidly to be stabilized in 1-2 years after the temperature inside has been steadied. The stabilized heat loss values which can be regarded as starting-points for dimensioning the heating and air-conditioning installations are 60-80% of the peak value, varying from 2 to 10 W/m^2. The annual temperature variation at the surface causes a variation of 1 W/m^2 in the heat losses conducted from a cavern with a roof of 7 metres. The annual variations in loss values cannot be observed when the roof thickness is more than 11 metres.

28271 (VTT-TIED–1063) **Absorption heat pump in oil-fired heating systems.** Laitinen, A. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). LVI-tekniikan Laboratorio); Aho, I. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Sep 1989. 85p. (In Finnish). Order Number DE90770753. Available from NTIS (US Sales Only), PC A05/MF A01.

The aim of this study is to survey the potential of absorption heat pumps in heating and cooling technology of buildings, especially in improving the energy efficiency of oil-fired heating systems. The report focuses on absorption heat pump principles, application of heat pumps in buildings, factors affecting the performance of absorption heat pumps and performance of absorption heat pumps connected with different oil-fired heating systems. Calculations are presented estimating the influence of absorption heat pump on the energy consumption of five example buildings. Technically absorption heat pump has a good application potential in HVAC-technology. Substancial energy savings can be achieved especially in low temperature heating systems. In the example buildings the average drop in energy consumption was 25%. Other technical advantages of the absorption heat pump are for example environmental factors (no CFC-compounds needed) and low noise level and low maintenance need resulting from almost total absence of moving parts. For the time being econommical aspects limit the application possibilities of absorption heat pumps. There are only a few systems in serial production which leads to relatively high investment costs. This together with the presently low price of energy in Finland results in long pay-back periods of absorption heat pump investments.

28272 (VTT-TIED–1077) **Calculation of the heat balance of a building: Methods and evaluation of reliability of programs.** Kalliomaeki, P. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). LVI-tekniikan Laboratorio); Kohonen, R. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Nov 1989. 146p. (In Finnish). Order Number DE90770758. Available from NTIS (US Sales Only), PC A07/MF A01.

Evaluation of energy analysis programs was studied and a basic evaluation methodology was developed to appraise the accuracy and applicability of a program. Bases of mathematical methods and physical models establishing the heat balance of a building were studied. Two large dynamic simulation programs, ESP and DOE-2.1C, were used as reference programs. In the theoretical part of the evaluation methodology bases of mathematical methods and physical models in a chosen program are compared to the reference programs. A data set of four tests was developed for comparison an energy analysis program with the reference programs. Tests can be used for identification of continuity conditions. Simulation results can be compared to the results form the reference programs and problem areas can be identified. A data set of unoccupied test house measurements was developed for verification of energy analysis programs. Weather data was collected at the test house site and a weather file was developed for verifying purposes. The data set for verification of energy analysis programs is composed of seven different periods. One test period consists of one week data and the periods represent different conditions of the year. Results from the reference programs and the energy consumption measurements showed reasonable agreement. The indoor-air temperature simulations were found to give too high temperature peaks and too strong temperature swings. Different applications and appropriate use of the reference programs were studied according to mathematical methods and physical models used in them. Reliability and capability of a new program can be evaluated by comparing it to reference programs.

28273 (VTT-TUTK–644) **Moisture transfer in building structures: Hygrothermal properties of building materials.** Saarimaa, J. (Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Poltto- ja Voiteluainelab.); Nieminen, J.; Rautiainen, L.; Ojanen, T.; Kohonen, R. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Aug 1989. 102p. (In Finnish). Order Number DE90770727. Available from NTIS (US Sales Only), PC A06/MF A01.

Models and calculation programs which simulate the moisture behaviour of building components require knowledge on various kinds of material properties as input values. In this study the moisture properties of fourteen common building materials have been measured as a function of moisture content of the material and temperature. The measured materials were cellular concrete, lime-sandstone, brick, two various gypsum boards, porous, semi-hard and hard wood fibre boards, wood//, wood c, bituminous fibre urethane. The following properties have been measured namely pore structure, sorption, vapour diffusion coefficient, moisture diffusivity, capillarity, permeability, thermal moisture diffusivity and the influence of freezing on moisture transport. All properties for every material have not been measured. The objective has been to get a general picture of various kinds of materials and their moisture properties. The results have been presented graphically. The deviation between single measurements of the same material may be rather great. Partly this is due to unhomogenities between specimens and partly due to changes in material properties during the measurements. There is still a great need for development of measurement methods for moisture properties of materials. One objective would be to have a sorption testmethod which is less time consuming than the methods of today. Another need is to evaluate by modern calculation methods in various climatological conditions the role and importance of material properties for the moisture balance of various kinds of building components. This would give valuable information on how exactly the moisture properties of materials should be known in various cases.

28274 **Production of soot by oil fired domestic heat equipment.** Volume 5. Butcher, T.A. (Brookhaven National Lab., Upton, NY (USA)); Wegrzyn, J. 15p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679–: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

88-90.9.

Studies on the basic emissions characteristics of conventional residential oil-fired heat equipment have been performed under laboratory conditions as well as in an actual field environment. These studies observed, in general, transient peaks of smoke, CO and gaseous hydrocarbons during startup and shutdown. For these reasons additional transient soot emission work was proposed to better qualify and quantify this problem for advanced systems. This work examined many design features such as excess air, heat exchanger pressure drop, draft, burner fan characteristics, and fuel shutoff valves for their effects on soot production. The objectives

were to determine the causes for the increased sooting in condensing systems and to evaluate the effect specific design features may have on soot production. The emphasis was placed on those features which might be practically incorporated into systems of the near future. This paper discusses design features which most significantly affect soot production by oil-fired domestic heating equipment.

28275 A critical examination of ducted mechanical ventilation in new residential housing in the Pacific Northwest. Volume 4. Parker, G.B. (Pacific Northwest Lab., Richland, WA (USA)). 15p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679–: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

88-75.5.

Researchers from the Pacific Northwest Laboratory (PNL) critically examined AAHX installations in several dwelling types. This paper describes problems noted with various AAHX installations. The author documents a field experiment conducted in energy-efficient manufactured homes that resulted in guidelines for improved design and installation of mechanical ventilation equipment.

28276 Overview of indoor air quality sampling and analysis. Levin, H. (Lawrence Berkeley Lab., CA (USA)). pp. 225 of Sampling and calibration for atmospheric measurements. Taylor, J.K. ASTM, Philadelphia, PA (USA) (1987). (CONF-8508258–: Sampling and calibration for atmospheric measurements symposium, Boulder, CO (USA), 12-16 Aug 1985).

During recent years, sampling and analysis of atmospheres for indoor air quality in non-industrial environments have increased substantially. Enhanced understanding of indoor air pollution has resulted. Increased recognition of the complexity of indoor environments has led to ever more sampling and analysis. Many methods used for indoor air are similar to those employed in workplace and ambient air. However, sampling conditions are often difficult; a very large number of pollutants are usually present, although at low concentrations; some pollutants of concern are at extremely low concentrations; and complex mixtures can create interferences. The author discusses how instrumentation requirements differ from those of ambient or industrial applications. Passive monitors and other unobtrusive monitoring equipment have received much attention. Sampling and analysis for biological aerosols will probably increase during the next few years. Other environmental factors are often critical and must also be characterized or measured Social science and health investigatory methods are often employed in conjunction with air monitoring.

28277 Promoting efficiency investments in new buildings. Koomey, J.G. (Lawrence Berkeley Lab., CA (USA)); Rosenfeld, A.H. vp. of Planning and forecasting. American Council for an Energy Efficient Economy, Washington, DC (USA) (1988). (CONF-8808247–: Planning and forecasting, Pacific Grove, CA (USA), 28 Aug - 3 sep 1988).

This paper describes a two-part policy to encourage building efficiency. The first part of the policy is a building energy rating scheme, which would require builders or developers to certify the energy consumption, peak demand, and annual operating costs of new residential and commercial buildings. This scheme would give building purchasers the information they need to make true life-cycle cost decisions. If market failures still remained after this information was supplied, then the second part of the policy, called the sliding-scale, energy/demand-target (SSEDT), would be implemented. The SSEDT sets a target peak demand and target electricity (or fuel) consumption per square foot for a particular building type, based on the energy rating calculations. Building or devices using more than the target would pay a fee into an efficiency fund, and buildings using less than the target would be given a rebate from the same fund. The target could be adjusted to collect the desired amount of revenue.

28278 Comparing building energy analysis software. Weiss, P. (Oak Ridge National Lab., TN (USA)); Brown, M. *Home Energy (USA)*, 6(5): 13-18 (Sep-Oct 1989).

The U.S. Department of Energy has developed several software packages for energy analysis, which can help auditors, program managers, architects, and others to calculate the energy effects of different design and retrofit options. This article describes four of these packages and notes some of their strengths and weaknesses.

28279 Building design: impact on the lighting control system for a daylighting strategy. Verderber, R.R. (Univ. of California, Lawrence Berkley Lab, Lighting Group, MS-46-125, Berkley, CA (USA)); Morse, O.C.; Jewell, J.E. *IEEE Transactions on Industry Applications (Institute of Electrical and Electronics Engineers) (USA)*, 25(2): 198-202 (Mar 1989).

The features of a multistory office building that successfully permit most of the space to be daylighted and the electric lights to be dimmed by a cost-effective centralized system are discussed. This system includes the use of light shelves, sloped ceilings, and proper building orientation and symmetry, and supplies only the ambient illumination. Measurements of the daylight illumination levels and the performance of the lighting control system indicate that daylighting can provide over 70 percent of the required ambient illumination through the year. Based on the installed cost of the lighting control system, its payback period is 2.2 years.

3202 Transportation

Refer also to citation(s) 27675, 28047, 28112, 29018, 29019

28280 (DOE/CE/15449–T3) **Fuel savings in the heavy trucking industry through cool storage: Technical progress report, third project quarter, December 20, 1989–March 19, 1990.** Instatherm Co., Cary, NC (USA). 1990. 3p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-89CE15449. Order Number DE90009636. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper discusses the design and initiate the fabrication of a production prototype for the cool storage system.

28281 (PB–90-153842/XAB) **Shared-ride paratransit performance evaluation guide. Final report.** Miller, J.H. Pennsylvania Transportation Inst., University Park, PA (USA). Nov 1989. 99p. Available from NTIS, PC A05/MF A01.

Shared-ride paratransit systems, ranging from public shared-ride taxis to human service agencies that provide specialized transit service for elderly and handicapped persons, provide essential, but often high-cost, mobility to residents in both urban and rural areas. Managers of these systems are increasingly being called upon to improve the cost-effectiveness of these services, and to provide performance reports to funding agencies, policy boards, and others to assure them that their funds are being spent wisely. The performance evaluation procedure described in the guide meets these two requirements by providing management with an important diagnostic tool to gauge the efficiency and effectiveness of shared-ride paratransit systems. It also provides external reviewers with a report card on the performance of the system. The guide offers recommendations on how to present the results of the analysis and to use the indicators to diagnose and correct problems with the system.

28282 (PB–90-165978/XAB) **Summary of survey data from the Katy, North, Northwest and Gulf transitways, April 1985 through November 1988. Interim report, September 1984-August 1989.** Bullard, D.L. Texas A and M Univ., College Station, TX (USA). Texas Transportation Inst. Aug 1989. 121p. (TTI–2-10-85-484-10). Available from NTIS, PC A06/MF A01.

In order to improve mobility within the Houston metropolitan area, the Metropolitan Transit Authority of Harris County and the Texas State Department of Highways and Public Transportation have joined together to implement an extensive system of transitways in the medians of the city's existing freeway system. These lanes are reserved for the exclusive use of high-occupancy vehicles. At present, carpools are permitted to use three of the four transitways in operation. Texas Transportation Institute (TTI) is currently monitoring the impacts associated with the implementation and operation of these facilities. In addition, TTI is also engaged in an assessment of public attitudes concerning the transitways. This assessment is being accomplished through the periodic distribution of survey questionnaires to both transitway users and nonusers.

The report presents the results of transitway user and nonuser surveys performed in the Katy, North, Northwest and Gulf Transitway corridors. In addition to obtaining socio-economic, demographic and travel information, the surveys were designed to: determine perceptions of transitway utilization; identify why individuals have chosen their present travel mode; and assess commuter attitudes and impacts pertaining to the transitways.

28283 (SAND–90-8201) **Direct numerical simulations of a plane compressible wake: Stability, vorticity dynamics, and topology.** Chen, J.H.; Cantwell, B.J.; Mansour, N.N. Stanford Univ., CA (USA). Thermosciences Div. c Nov 1989. 180p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DR00789. Order Number DE90007934. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

Recent interest in supersonic combustion and problems of transatmospheric flight has prompted renewed research efforts in laminar-turbulent free shear flow transition. In the present work, linear stability theory and direct numerical simulations are used to study the effect of Mach number on the linear, nonlinear, and three-dimensional aspects of transition in a plane compressible wake. Direct numerical simulations are also used to study the sensitivity of a compressible wake to (1) phase effects and (2) two- and three-dimensional subharmonics. A linear stability analysis shows that the influence of increasing Mach number is stabilizing, resulting in reduced growth rates for both antisymmetric and symmetric modes of the wake. This reduction is due to baroclinic and dilatational effects as revealed from the linear eigenfunctions. For both low and high Mach numbers, the least stable wave is a two-dimensional antisymmetric mode aligned with the stream-wise direction. Three-dimensional simulations were performed to study the effect of phase angle between a fundamental and a pair of oblique waves on the development of the large-scale structures in a wake. Finally, the topology of the computed velocity, vorticity, and pressure gradient fields is determined using a generalized three-dimensional critical point theory. 78 refs., 83 figs.

3203 Industrial and Agricultural Processes

Refer also to citation(s) 27615, 27616, 27804, 27805, 27817, 27818, 27821, 27824, 27940, 27950, 28222, 28231, 28254, 28341, 28688, 28952, 28964, 28986

28284 (AEL–13) **Planning aids for the use of electric appliances in greenhouse horticulture.** Meyer, J.; Dickob, D.; Dierend, A.; Hoelscher, T. Arbeitsgemeinschaft fuer Elektrizitaetsanwendung in der Landwirtschaft e.V., Essen (Germany, F.R.); Hannover Univ. (Germany, F.R.). Inst. fuer Technik in Gartenbau und Landwirtschaft. Apr 1989. 97p. (In German). Order Number DE90780109. Available from NTIS (US Sales Only), PC A05/MF A01.

Information on better planning and the economic use of energy is given with respect to several intensive-energy areas. Examples and measurements made under frequently occurring operational conditions in some areas where electric appliances are used complete the picture. The following areas are adressed: artificial lighting; forced ventilation; air heating; irrigation; other appliances. (orig.).

28285 (CONF-900676–3) **Plastic wastes and the potential for waste minimization.** Curlee, T.R. Oak Ridge National Lab., TN (USA). 13 Mar 1990. 16p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From 83. annual meeting and exhibition of the Air and Waste Management Association; Pittsburgh, PA (USA); 24-29 Jun 1990. Order Number DE90009813. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper examines plastic waste minimization from an economic perspective and addresses several issues: the definition and measurement of plastic waste minimization, projections of quantities and sources of future plastic wastes, the role of government in promoting plastic waste minimization. For the purposes of this paper, plastic waste minimization is defined as any activity at the manufacturing level that (1) reduces the quantity of plastics used in products, (2) reduces the toxicity of plastics used in products, or (3) directly or indirectly promotes the recycling of plastic wastes. Several conclusions are drawn. First, the potential for plastic waste minimization is difficult to qualify, much less quantify, because waste minimization must be discussed in relation to the potential indirect consequences of minimization efforts. Second, valid arguments can be made to defend government actions to encourage plastic waste minimization. Those arguments focus on market failures resulting from environmental externalities and the failure to price solid waste disposal at marginal cost. Several alternative government measures are available to encourage waste minimization – with various pros and cons. Third, measures that are currently being discussed to promote quantity reductions are not likely to have a significant effect on the quantities of plastic waste produced. Fourth, measures to reduce the toxicity of plastics are difficult to evaluate because there is no concensus on the environmental threat posed by currently-used plastics. The current evidence suggests that plastics do not pose significant environmental problems when either landfilled or incinerated. 22 refs., 4 figs., 4 tabs.

28286 (DOE/ID/12792–1) **DOE Advanced Industrial Heat Pump program: An analysis of a kraft pulp and paper mill.** Southern Co. Services, Inc., Birmingham, AL (USA); Linnhoff March, Inc., Leesburg, VA (USA). 15 Jan 1990. 139p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FC07-88ID12792. Order Number DE90008326. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

Southern Company services (SCS) has completed an analysis of a kraft pulp and paper mill to determine the technical potential and economic feasibility of industrial process heat pumps. This study was carried out under the sponsorship of the US Department of Energy's Office of Industrial Programs (OIP). The objective of the OIP's Advanced Industrial Heat Pump program is to assess the potential application of process heat pumps to a large number of energy-intensive industrial processes as a means of improving overall energy efficiency. SCS served as the prime contractor for a team of participants involved in the project. In addition, SCS collected process data, developed overall process flow diagrams, and calculated heat and material balances for the processes considered. The Advanced Industrial Heat Pump program is a three-phase program. Phase 1 consists of Heat Pump and Process Assessment; Phase 2 — Heat Pump Design and Installation of Phase 3 — Heat Pump Evaluation During Operation. This report presents results from the Phase I study of Union Camp's kraft pulp and paper mill located in Prattville, Alabama.

28287 (HNEI–90-1002) **Cogeneration in the Hawaiian sugar industry.** Kinoshita, C.M. Hawaii Natural Energy Inst., Honolulu, HI (USA). Jan 1990. 73p. Sponsored by U.S. Agency for International Development; Tennessee Valley Authority. Contract TV-73595A. Available from OSTI; Hawaii Natural Energy Institute, University of Hawaii at Manoa, 2540 Dole Street, Holmes Hall 246, Honolulu, HI 96822.

For nearly a century the Hawaiian sugar industry has produced most of the steam and electricity needed to process sugarcane and to power its factories and irrigation pumps. Judicious use of bagasse and cane trash has made the Hawaiian sugar industry among the most efficient in the world in converting biomass into electricity — in comparison with typical worldwide cane-to-electricity productivities of ~10 kWh per ton of cane, Hawaiian sugar factories today generate, on average, about 60 kWh per ton of cane and, in some factories, 100 kWh or more. Plantations in Hawaii produce about 800 million kWh annually, and, after satisfying virtually all of their internal power requirements, export roughly 400 million kWh to public utility companies. To attain world prominence in generating and exporting power from bagasse, Hawaiian sugar companies have had to address numerous technical, operational, regulatory, and contractual issues relating to the production and distribution of steam and electricity. Prior to 1970 the development of electricity generation in the Hawaiian sugar industry was shaped almost entirely by technical developments — better utilization of the available biomass resources; consolidation of steam-generation facilities into fewer, larger, and more efficient units; and increased operating pressures and temperatures of steam and electrical generating units and better heat recovery to achieve higher thermal efficiency in the cogeneration plant. In more recent years, however,

non-technical issues have influenced electricity generation and sale more than technical factors. 20 figs., 5 tabs.

28288 (PB–90-160789/XAB) **Waste Reduction Assistance Program (WRAP): On-site consultation audit report, manufacturing/distributing company.** Alaska Univ., Fairbanks, AK (USA). Marine Advisory Program. 1 Jun 1988. 31p. Available from NTIS, PC A03/MF A01.

The study reports on one manufacturing/distributing company. The study makes recommendations for the reduction of hazardous waste for the company and for others in the industry on areas like recycling and chemical storage.

28289 (PB–90-161548/XAB) **Development of a gas-fired rethermalization oven. Final report, April 1987-September 1989.** Himmel, R.L.; Stack, R.E. American Gas Association Labs., Cleveland, OH (USA). Sep 1989. 84p. Available from NTIS, PC A05/MF A01.

The report describes the design and performance of two gas-fired rethermalization ovens developed to provide a gas-fired alternative to the electric rethermalization ovens currently used in the cook-chill process. One approach used a power burner while the other approach used an atmospheric burner in an induced draft combustion system. Both fire-tube systems were rated at 90,000 Btu/hr input. The new gas-fired oven was forced convected by a single motor/blower combination operating at 1750 RPM and which circulated 2,500 ft/min of hot air for rethermalization as well as conventional forced convection oven cooking. The unit was designed to accommodate 10 steam table pans, each 12 inches x 20 inches x 2-1/2 inches deep and is modular to permit relatively easy expansion to a 22 pan oven. The overall design and operating parameters were met by heating 150 pounds of macaroni and cheese (10 standard steam table pans, 15 pounds per pan) from 37 F to an average serving temperature of 160 F in 45 minutes; oven preheat times less than 10 minutes; efficiencies of approximately 50 percent; and excellent results when cooking full loads of frozen cherry pies, sheet cakes, and buttermilk biscuits. The version using an atmospheric burner is planned for commercialization by the cooperating manufacturer.

28290 (PJM–CE02952, pp. 80-83, Paper 14) **Case study: Canadian Forest Products Ltd., Howe Sound Pulp Division, Port Mellon, B.C.** Chalmers, B. (Canadian Forest Products Ltd., Port Mellon, BC (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The upgrading of a boiler by installation of a new burner and burner management system at Canadian Forest Products Howe Sound pulp plant is described. The Howe Sound plant uses steam to run a turbogenerator and drive many motors in the plant. The largest input source supplying about 60% of the steam prior to the project was a recovery boiler system which burned black liquor residue. Heavy oil produced about 26% of the energy needs and consumed about 76% of energy dollars. 64% of oil burned in the plant was consumed by power boilers. A decision was made to investigate upgrading of the power boilers. The existing boilers were capable of using both oil and hog fuel. Historically about 54% of the steam was produced by oil. The major factors involved in consumption of so much oil in these boilers were as follows: local hog fuel of poor quality due to high moisture content; oil burners were unreliable, that is, they were sometimes difficult to light quickly when auxiliary fuel was needed; there was poor air distribution in the boiler and outside air was leaking into the system; the high amount of added air which the system required meant loss of a 10% great deal of energy. A new burner system and burner management system was installed. These burners were capable of operating on about 10% excess air. New air registers eliminated air leakage. Burners are monitored individually in the control room to ensure a safe operation. Projected savings are about $685,000/y. The project received a FIRE grant which should reduce the payback period from 3.1 years to about 2.5.

28291 (PJM–CE02952, pp. 77-79, Paper 13) **Case study: B.C. Clean Wood Ltd. Thermal fluid system.** Silcox, R.W. (B.C. Clean Wood Ltd., Surrey, BC (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: Conference on biomass - an alternate source of energy, Vancouver (Canada), 8 Nov 1982; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper describes the feasibility study and commissioning of an 8 million BTU wood waste energy conversion system at the B.C. Clean Wood Ltd. in Surrey, B.C.. B.C. Clean Wood operates 3 dry kilns in its custom wood perservation and cutting services. Approximately 48 million board feet of lumber are processed each year. There were three reasons for considering a waste burner: the high cost of having waste wood hauled away; the high gas costs for the gas kilns; and the requirement for higher heating capacity than the existing gas-fired kilns could produce. A financial analysis comparing estimated total cost versus a monthly saving of $12,000 in gas costs provided an estimated payback period of 5 1/2 years. Additional saving in truckage fees amounted to $10,000/m. Problems were encountered in meeting pollution regulations. A thorough investigation of burner technology, testing of the burner versus pollution regulations, and a study matching fuel with prospective burners are recommended.

28292 (PJM–CE02952, pp. 60-65, Paper 10) **Case study: B.C. Timer Ltd., Prince Rupert Mill hog fuel drying system.** Layborne, R.E. (B.C. Timber Ltd., Prince Rupert, B.C. (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper describes the rebuilding of an oil-fired boiler at B.C. Timber so that it could produce 300,000 lb/h of steam using 900 tons/d of wet hog fuel. This boiler had originally been purchased to burn hog fuel but had functioned poorly. The rising cost of natural gas and the costs of off-site trucking of wood waste provided the incentive for the project. Part of the project involved the construction of a new hog fuel treatment system which delivered good quality fuel to the furnace. The methods used include the following: installation of low excess air burners, installation of arches on the front and rear walls of the boiler to increase furnace recirculation; and a floor grate design involving an air supply with a high pressure drop to ensure even distribution of air. Additional heating for the air was installed in the form of natural gas heaters. The combustion zone was lined with refractory. An hydraulically operated rake was used to remove ashes. Performance was monitored by computer. This system cost $22,000,000 to install and provides saving of $2.10/1,000 pounds of steam produced.

28293 (PJM–CE02952, pp. 54-59, Paper 9) **Case study: Cogeneration of power at the Gold River pulp mill.** Clark, D.W. (Tahsis Co. Ltd., Gold River, BC (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This presentation provides an overview of a cogeneration installation at the Gold River Pulp Mill on Vancouver Island. This mill produces approximately 680 air dry tonnes/d of bleached market Kraft pulp. The production of this pulp requires about 160,000 pounds/h of process steam reduced to 160 pounds per square inch gauge (PSIG), and 340,000 pounds/h reduced to 60 PSIG. Electrical power requirements total about 21.2 megawatts. The volume of steam required and frequent interruptions of electrical power supply lead to the implementation of a cogeneration scheme. The installation selected enabled the production of 21.8 megawatts of power and 49,000 pounds/h of steam using 80,000 m^3 of hog fuel annually. In this installation hog fuel bark is initially mechanically pressed to reduce moisture levels from 65 to 55% and the fuel is

screened to remove off-size particles. Boiler burners have been replaced to provide a more reliable steam header pressure. Steam from the boiler is used to operate a turbo-generator. Hog fuel is the primary fuel with oil firing used as a supplement. The hog fuel is expected to replace 85,000 barrels of oil per year.

28294 (PJM–CE02952, pp. 139-144, Paper 25) **The inclined water cooled grate.** White, D.B. (Foster Wheeler Ltd., St. Catherines, On (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

The inclined water cooled grate, used principally as a combustor of fibrous materials for steam generation, is described. The grate is inclined at approximately 55 ° with fuel added at the top and passed downward. Drying, combustion of volatiles, and final combustion takes place successively as the fuel passes downward through the furnace. Ash is blown to the front by intermittant steam jets, and removed by rake. Air is injected through a zoned air plenum at the bottom of the grate and overfire air is added via ports at 5 separate levels. The inclined grate normally requires some form of assistance to burn fuels more that 57% moisture. The addition of a refractory covered arch to reflect heat back to the fuel bed allows the combustion of fuels up to 60% moisture with no assist. Fuel sizes from fine particulates up to 4 x 18 in. cross section can be burned. Wood fuels have characteristically a wide variation in heating value. Heat output is maintained in this furnace by control of the air flow rate rather than the fuel feed rate. The inclined grate furnace has substantially lower maintenance requirements than furnaces with travelling grates.

28295 (PJM–CE02952, pp. 117-119, Paper 22) **A manufacturing plant bioenergy system.** Beazer, B. (Nestles Corp., Chesterville, ON (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper describes a project aimed at replacing an old boiler which burned spent coffee grounds and natural gas with a new system which operates entirely on coffee grounds. In the old system wet coffee grounds were partially dried in a press before burning. The press left the grounds so moist the natural gas fuel supplement was required to make them burn. Coffee grounds have an energy value of about 11,000 BTUs per pound when dry and can burn very well. A new system comprised of a horizontal screw press which reduces the coffee grounds to 50% water and a new boiler were installed. This system will allow the burning were installed. This system will allow the burning of spent grounds without the assistance of natural gas. The new equipment should increase efficiency about 15% and save 18,000 million cubic feet of gas per year. The system will burn about 10,000,000 pounds of coffee grounds per year.

28296 (PJM–CE02952 vp., Paper 21) **Energy in greenhouses.** Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper provides a summary of capital costs incurred in using conventional energy sources (no. 2 oil, no. 6 oil and natural gas) to heat greenhouses at different locations across Canada. Costs of energy commodities, projected heat costs in $/GJ, supplemental heating degree-days and estimated annual greenhouse heating costs using no. 2 oil, no.6 oil and natural gas is provided by province or by specific location within each province. Fuel oil costs are forecasted to be highest in Quebec at 42.9 cents/l and lowest in Alberta at 41.4 cents/liter in 1986. Natural gas prices will be highest in the Atlantic provinces at 7.89$/GJ and lowest in Alberta at 3.66$/GJ. Heat costs will be highest in the Atlantic provinces at 16.88, 12.7 and 11.27 $/GJ for no.2 oil, no.6 oil and natural gas respectively. They will be lowest in Alberta at 16.36, 10.92 and 7.11 $/GJ. The forecast greenhouse heating costs using no.6 oil in $/m ^{2} for 1986 is 41.60 in St. John's Nfld.; 38.02 in Charlottetown, P.E.I; 34.12 in Halifax, N.S.; 39.32 in Fredericton, N.B.; 40.82 in Quebec, P.Q.; 37.13 in Montreal, P.Q.; 29.26 in Toronto, Ont.; 47.02 in Winnipeg, Man.; 47.00 in Regina, Sask.; 43.43 in Edmonton, Alta. and 22.45 in Vancouver, B.C.. 5 tabs.

28297 (SIEMENS-KWU-U9–414/88/007) **Development of processes for disposal of transformers using askarel and planning of pilot plant. Final report.** Lisson, J. (Siemens AG Unternehmensbereich KWU, Nuernberg (Germany, F.R.). Geschaeftsbereich Transformatoren (Germany, F.R.)); Schreck, W.; Walter, H.; Bege, D.; Kratz, P. Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Jun 1988. 208p. (In German). Contract BMFT 1430354/2. Available from Siemens AG Unternehmensbereich KWU, Offenbach am Main (Germany, F.R.).

A material recovery plant has been developed for use in the disposal of electrical equipment and components, such as transformers which use askarel as an insulation material. The design was based on a decontamination process using solvent. For this, the askarel transformers are first drained and then pre-cleaned on the inside using solvent steam to allow the active transformer parts to be removed and disassembled by hand. The various transformer parts (tank, core, coils, small parts, bolts etc.) are treated using a specially-developed process. The tanks are cleaned thoroughly using solvent steam ($\leq$ 10 ppm residual PCB). The coils are treated as follows: Shredding, unwinding, sorting in an air stream, loosening of remaining insulation from shredded metal (e.g. copper) by means of water wash tanks and intense cleaning (up to 10 ppm residual PCB) by means of perchloroethylene wash tanks. Core laminations separated in a special machine, small parts, bolts etc. are routed directly to perchloroethylene wash tanks for intense cleaning. The decontaminated scrap can then be recycled. Insulation and wood containing askarel, and askarel oil can be transported to a licensed high-temperature incineration plant. (orig.) With 34 refs., 24 tabs., 36 figs.

28298 (SLU-IMB–40, pp. 143-151) **Experiences and development of anaerobic waste water cleaning i.a. toxic waters in forest industry.** Huss, L. (Purac AB, Lund (SE)); Olsson, L.E. Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish). (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

The ANAMET process, an anaerobic - aerobic wastewater treatment process is presented. In the Nordic countries 15 plants are in operation. The origin of the wastewaters for these plants is beet sugar factories, other food industries or pulp and paper industries. Two plants treating wastewater from sodium sulphite pulpmills are presented. One of these plants have demonstrated the efficiency of the gas washing and recirculated system to remove toxicity caused by hydrogen sulfide. About 800 metric tons of sulphur can be recovered. A high BOD and COD removal is achieved, 95 and 70 % respectively, over the plant. The methane production was 1987 equivalent to 2500 metric tons of oil per year. A new pre-treatment process for sulphur removal was developed and tested in a pilot plant, completed with a sulphur removing step at Junckers Industries in Denmark. The influent water is first recirculated over an anaerobic tricling filter in which sulphate and sulphite are reduced to sulphide. The sulphide is stripped off from the liquid by washed recirculated biogas. More than 85 % of the inorganic sulphur was removed in the filter. The BOD removal over the entire system was over 90 %. A future full-scale plant will produce methane gas equivalent to 2500 metric tons of oil per year.

28299 (STU–86-3891) **Energy study of soft crepe paper manufacturing.** Falk, M. (STFI, Stockholm (SE)); Hollmark, H. Swedish National Board for Technical Development, Stockholm (Sweden). 1 Nov 1989. 35p. (In Swedish). Order Number DE90770866. Available from NTIS (US Sales Only), PC A03/MF A01.

The study produced the following main results. There are possibilities of energy savings by two forming of CTMP/sulphate instead of CO-forming. The heating of the press felt represents an substantial part of the soft paper drying heat losses. Electric IR-drying provides from energy consumption viewpoint favourable way of increasing productivity by profile conection and increased drying capacity.

28300 (SV-US–1989-37) **Electric heating in drying of paper and card board.** Hannervall, L. Swedish State Power Board, Vaellingby (Sweden). 14 Aug 1989. 27p. (In Swedish). Order Number DE90770785. Available from NTIS (US Sales Only), PC A03/MF A01.

The efficient use of energy in industrial processes in an important part in the R and D program of Vattenfall (Swedish State Power Board). The Pulp and Paper Industry is the most energy demanding branch in Sweden. Especially drying processes are of great economic importance in this context. In co-operation with some of the big customers, Vattenfall has investigated the possibilities for infrared technique in five pilotplants and a testequipment for microwave drying. The five pilotplants concerning electric-infrared drying of paper and carton in five of Vattenfall's big customer-plants have on the whole been sucessful and produced interesting results and knowledges. Now the new technique is established and generally brings essential advantages in operational and economical respect. Improved product quality and increased volume of production have proved to be greater importance than change in energy costs. Apparently it's justified to expect further enlargement in the use of electric IR even if the present relation of different energy prices will change. The fact that several IR-equipments have been taken in operation during the last year argues in favour of this opinion.

28301 (VTT-SYMP–103, pp. 35-39) **Utilization of process waste to conserve resources and reduce pollution.** Yu, Y. (Academy of Science Ministry of Light Industry Beijing (China)). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

Some mills of the Chinese light industry have practiced to use process waste as agricultural and industrial resources to a certain extent. A few examples are given to show the contribution to resource conservation and environment improvement in such efforts.

28302 (VTT-SYMP–103, pp. 55-60) **Outokumpu flash smelting - an efficient and non-polluting metallurgical process.** Sulanto, J. (Outokumpu Oy, Espoo (Finland). Engineering Division). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

The flash smelting method has been developed by Outokumpu to produce non-ferrous metals such as copper, nickel and lead from sulphide concentrates. The most important advantage of the method is the utilization of the latent heat of concentrate in the smelting. Nearly as important as the heat utilization is the very low impact on the environment. Sulphur dioxide and dust emissions being common problems in non-ferrous smelters can easily be controlled in the Outokumpu flash smelting process without additional investment in the plant. The following presentation describes the most common application of the process, the copper flash smelting. The smelting of copper concentrates by the Outokumpu licence is practised in over twenty smelters around the world. In principle, the same advantages can be reached also in the nickel and lead flash smelting but process conditions, however, differ a little from the copper flash smelting.

28303 (VTT-SYMP–103, pp. 61-71) **Outokumpu ferrochrome process.** Daavittila, J. (Outokumpu Oy, Espoo (Finland). Engineering Division); Honkaniemi, M. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

Construction of a new ferrochrome smelting line in 1985 and modification of the old line in 1986 raised the smelting capacity at the Tornio Works of Outokumpu to 150 000 - 200 000 t/a, depending on the quality of raw material. A new type of preheating equipment was developed to process soft and friable lumpy ore, which now can be smelted together with pellets in a closed electric furnace. Thus the new production facilities are capable of processing both the coarse and the fine fraction, a division which is typical of the Kemi chromium ore. A new process control system, which is necessary when controlling big production routes like this, was also developed. Automation is based on comput erized process control systems and separate control instruments with programmable logistics. The energy economy of the plant was optimized by intensified utilization of waste energies generated throughout the process route. In consideration of ever-tightening requirements of environmental protection and work hygiene process gas handling was made more efficient with purification equipment of a new type and by distributing process waters to the process circulation.

28304 (VTT-SYMP–103, pp. 73-84) **Reduction of environmental pollution by the lead glass industry of the Federal Republic of Germany.** Kaiser, A. (Fraunhofer-Institut fuer Silicatforschung, Wuerzburg (FRG)). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

A survey is given over technological developments of the last years within the lead glass producing industry of the Federal Republic of Germany with impact to environmental pollution reduction. Special attention is put on clean air technologies including recycling of filter dusts, to the removal of heavy metals from recycling and waste waters and to environmental improvements of the acid polishing process.

28305 (VTT-SYMP–103, pp. 207-215) **Removal of cadmium and lead from industrial wastewater.** Jain, S.K. (Indian Institute of Technolog, New Delhi (India)); Jha, N.K.; Vasudevan, P. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

A new method has been proposed for the removal of cadmium and lead from industrial wastewater after coprecipitation of their pyrrolidiene dithiocarbamate complexes with microcrystalline naphtalene. Conditions such as pH, buffer, reagent concentration, shaking time etc. have been optimised for the quantitative adsorption of metal pyrrolidiene dithiocarbamate complexes onto naphtalene. The salient features of this method are that it does not involve any sophisticated contruction and mechanisation. It is simple, convenient, rapid, and applicable to all types of industrial wastewater samples.

28306 (VTT-SYMP–103, pp. 273-284) **Cleaning and heat recovery of cement kiln bypass gas with fluxflow technology.** Gustafson, T.-H. (Partek Corporation, Pargas (Finland). Cement Division, Pargas Plant); Ritakallio, P.; Heikkilae, J. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

Fluxflow represents a novel technology comprising a system where the process gases are quenched in a circulating fluid-bed for combined heat recovery and gas cleaning. The separation of solidified impurities is normally carried out by conventional cyclones after cooling the circulating gas-solid suspension in a heat exchanger. After successful pilot testing at non-ferrous smelters with coal gasification and at cement kiln the first moderate size industrial Fluxflow unit has been in continuous operation since early 1987 as alkali bypass for a cement kiln. The paper describes the Fluxflow technology in general, the results of pilot scale testing at the cement kiln under real plant conditions and the results of the

process study carried out during ordinary operation at the Partek facility. The mechanism of the gas cleaning will be discussed. Due to the quenching of incoming gases in the circulating fluid bed the formation of submicron alkali fumes is largely avoided. The removal of alkali components in excess of 90% is achieved with cyclones only. The heat is recovered as hot water into a district heating network. In comparison with conventional solutions without heat recovery the Fluxflow system is very economical. The investment in gas cleaning and environmental control turns out to be profitable because the heat is recovered as a saleable product.

28307 (VTT-SYMP–103, pp. 359) **Safety analysis of a black liquor recovery boiler plant.** Rouhiainen, V. (Technical Research Centre of Finland, Tampere (Finland). Occupational Safety Engineering Laboratory). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

Abstract only. SPENT LIQUORS/waste product utilization; WASTE PRODUCT UTILIZATION/risk assessment; PROCESSING; PAPER INDUSTRY; BOILERS; SAFETY ENGINEERING

28308 (VTT-SYMP–103, pp. 345) **Vapour cloud modelling in the assessment of major toxic hazards.** Kakko, R. (Technical Research Centre of Finland, Tampere (Finland). Occupational Safety Engineering Laboratory). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

Poster presentation. INDUSTRIAL WASTES/risk assessment; SAFETY ENGINEERING; TOXIC MATERIALS; TOXICITY; HAZARDS; MATHEMATICAL MODELS; PROCESSING; CLOUDS; WEATHER; VAPORS; MITIGATION

28309 (VTT-TIED–1058) **Non-destructive measurement of wood: Part 2. Mirowave measurements.** Lankinen, A. (Valtion teknillinen tutkimuskeskus, Espoo (Finland). Puulaboratorio). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Sep 1989. 27p. (In Finnish). Order Number DE90770746. Available from NTIS (US Sales Only), PC A03/MF A01.

This research note presents the basis of microwave technology from the point of wood measurements and some prototype machines made for the mechanical forest industry. Microwave techniques are promising research methods for wood. They have been used since the beginning of the seventies. Microwave technology becomes cheaper and the usefulness of it becomes better year by year. Experiences until now have been mostly good, but in some cases the interpretation of the measurement results has not succeeded in the best possible way. Microwave measurements are at their best when it is possible to measure wood with other types of sensors at the same time so that e.g. temperature sensitivity can be disregarded. The development of microwave technology for wood measurements is slow in Finland because of the low number of companies which are interested in it. Most research projects in Finland have been pursued by the Radio Laboratory of the University of Technology in Helsinki.

28310 (VTT-TUTK–642) **Chemical composition and combustion properties of black liquor.** Alen, R. (Valtion teknillinen tutkimuskeskus, Espoo (Finland). Polttoainejalostustekniikan laboratorio); Noopila, T.; Hupa, M. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Aug 1989. 45p. (In Finnish). Order Number DE90770733. Available from NTIS (US Sales Only), PC A03/MF A01.

Combustion behaviour of black liquors was studied by burning single liquor droplets of various liquor samples, (dry solids content of 60%) in a controlled laboratory furnace at the temperatures of 700 deg C and 800 deg C. The liquor samples originated from the different delignification stages of kraft-AQ, and soda-AQ pulping of pine wood and birch wood. One series of cooking liquors was also made by delignifying the same wood materials after removal of the extractives. All liquors were characterized with respect to their content of lignin, aliphatic carboxylic acids, other organics, and inorganics. In the combustion experiments the time of drying, pyrolysis, and char burning was determined for each liquor sample. These results indicated that there were typical differences in the combustion properties of different liquors. Also combustion swelling clearly increased with cooking time for most of the cases. In addition, the influence of main component groups of black liquors on the combustion stages studied was discussed.

28311 (VTT-TUTK–649) **Mutagenicity of cooked foods.** Tikkanen, L. (Valtion teknillinen tutkimuskeskus, Espoo (Finland). Elintarvikelaboratorio). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Sep 1989. 43p. (In Finnish). Order Number DE90770726. Available from NTIS (US Sales Only), PC A03/MF A01.

In this study the mutagenic activity in different kinds of ordinary Finnish foods was determined using mainly the Ames Salmonella bacterial assay. The purpose of this study was also to acquire the technical capability to study cooked food mutagens and to get basic informavtion about the mutagenic activity of foods under different cooking conditions. The samples tested were different kinds of ready-to-eat foods. Products were industrially heat-processed by frying and roasting, sterilization, smoking, deep-frying, spray-drying and UHT-treatment. According to the results, the majority of the fried and roasted food samples containing meat or fish were clearly or strongly mutagenic. Some of the products processed by sterilization and deep-frying were marginally mutagenic. The effect of the frying temperature on the mutagenicity in the Ames test was studied with minced meat. The mutagenic activity of the fried meat clearly correlated with the frying temperature. There were conspicuous differences in mutagenic activity between different fried and roasted products. Charcoal-grilled fish and the surface layers of the grilled meat and chicken were strongly mutagenic. Meat and fish hamburgers were in most cases only slightly mutagenic. The mutagenic activity was stronger in the surface layers of the products than in the inside. Also reheating by frying increased the mutagenicity of meat patties clearly. Differences in mutagenic activity between equivalent products of different manufacturers were evident in many cases. Variation of the mutagenicity was most conspicuous in the grilled products. This variation indicates that the industrial processing of food has a marked effect on the mutagenic activity of the final product, which thus might be reduced by modifying the process. The solvent extraction method used in this study was more effective than the Blue-Cotton method for the isolation of mutagenic compounds.

28312 **Proceedings of the second international conference on new frontiers for hazardous waste management.** 591p. Environmental Protection Agency (US), Cincinnati, OH (USA) (1987). (CONF-870941–: 2. international conference on new frontiers for hazardous waste management, Pittsburgh, PA (USA), 27-30 Sep 1987).

EPA/600//9-87/018F.

These proceedings contain 62 papers grouped under the heading of: Thermal destruction; Physical/chemical treatment; Biological treatment; Land disposal; Solidification; Posters; Recycle/Reuse.

28313 **The risk associated with the research of an innovative process for the thermal destruction of hazardous substances: A case study.** Wentz, C.A. (Argonne National Lab., IL (USA)). vp. of Proceedings of the international conference on incineration of hazardous, radioactive and mixed wastes. Wolfeboro, NH (USA), Irvine, CA(USA) (1988). (CONF-880526–: International conference on incineration of hazardous, radioactive, and mixed wastes, San Francisco, CA (USA), 3-6 May 1988).

An innovative thermal process that offers considerable potential for highly efficient destruction of hazardous waste is high-temperature gasification. Destruction and removal efficiencies (DREs) of at least 99.999999%, and possibly 99.9999999%, should be achieved in the gasification of hazardous substances. Recognizing the commercial potential of such an innovative process, Union Carbide Corp. contracted with the University of North Dakota Energy Research Center at Grand Forks, N.D., to demonstrate this technology by destroying polychlorinated biphenyls (PCBs) in the Center's existing pilot-plant lignite gasifier. After Union Carbide and the Energy Research Center agreed on the scope of the experimental program, the Center applied for and received the necessary state and federal environmental permits. Shortly after these permits

were granted a group of local citizens came out against the PCB program. The project came under intense public scrutiny, the state operating permit was revoked, and the project was terminated. The authors present their analysis of this situation.

28314 **Process simulation as a tool for waste minimization.** Brown, M.D. (Pacific Northwest Lab., Richland, WA (USA)); Freeman, H.D.; Robertus, R.J. pp. 60 of Proceedings of the 1987 Pacific Northwest metals and minerals conference (abstracts): Modern mineral and metal technology. Albany Research Center, Albany, OR (USA) (1987). (CONF-8704166–: Pacific Northwest metals and minerals conference, Portland, OR (USA), 26-28 Apr 1987).

Chemical process simulation is a powerful tool for the process engineer who is responsible for both energy savings and waste handling. Chemical waste minimization is now a national priority. Many companies are evaluating different in process technologies to both save energy and to minimize the number of end of pipe waste streams that they must react. Many process alternatives can be quickly and economically investigated using a process simulator. Current process simulators make quick work of flowsheets involving organics, solvents, refinery wastes, aqueous and electrolyte streams, metal plating wastes, and suspended solids. Such simulators can produce complete heat and material balance as well as an economic evaluation of each process. This paper examines situations in which a simulator might be useful, and outlines some currently available software.

28315 **Metal detoxification of wastewater by bioaccumulation.** Sproull, R.D. (Oregon State Univ., Corvallis, OR (USA). Dept. of Chemical Engineering); Premuzic, E.T.; Lin, M.S.; Kukacka, L.E. pp. 60 of Proceedings of the 1987 Pacific Northwest metals and minerals conference (abstracts): Modern mineral and metal technology. Albany Research Center, Albany, OR (USA) (1987). (CONF-8704166–: Pacific Northwest metals and minerals conference, Portland, OR (USA), 26-28 Apr 1987).

This paper reports a study of the feasibility of using microorangisms for the detoxification of a 720,000-GPD industrial wastewater stream containing low levels of Cu, Mn, Ni, Zn and Cr (as chromate). Batch experiments were characterized by short contact times (30 min or less) between the metal solution and biomass, low pH (2.5 to 6), and the absence of agitation. Of the microorganisms investigated E. coli was found to be the most efficient. However, to reduce chromium to drinking water standards, the chromate ions had to be reduced to chromic ions. The major units in the proposed bioaccumulation process include: a chromate reduction facility, a metals adsorption vessel, a biomass growth fermentor, a biomass-water separations facility, a shot pond and a back neturalizer. An economic analysis of this process indicates that the industrial waste stream can be traced to one cent per gallon of waste,which is on the same order as conventional chemical treatment processes.

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Refer also to citation(s) 27812, 27838, 27939, 28123, 28204, 28277, 28313, 28315, 29167

28316 (DOE/CE/26574–T2) **Feasibility study, central chilled water system, downtown Baltimore, Maryland.** Baltimore Thermal Energy Corp., MD (USA). 5 Mar 1990. 175p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-88CE26574. Order Number DE90009394. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

On September 6, 1988, Baltimore Thermal Energy Corporation (BTEC) received Contract F01-88CE26574 from the US Department of Energy (DOE). This contract in the amount of $54,275 was to conduct a feasibility study of the Baltimore Central Cooling Project (hereafter referred to as the Project). The Project period was from September 6, 1988 to March 5, 1990. This report is submitted under the requirements of this contract. BTEC conducted a study of the feasibility of installing and operating a localized district cooling loop for a specified high density area in downtown Baltimore. This particular project was selected for study because of its high potential for implementation. The Project consisted of four City owned buildings, Provident Bank Building, and Mercy Medical Center; all within a two block area. It is planned that a central cooling plant will be installed in the basement of the City Courthouse East and will distribute cooling water to the other nearby buildings in the project.

28317 (FSC–CE02991) **Waste heat recovery retrofit project.** Ferguson, Simek, Clark Ltd., Yellowknife, NT (Canada). Aug 1987. vp. (CE–02991). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report provides the results of the experience gained and the guidance for the replication of a waste heat recovery system in Lac La Martre, Northwest Territories. In the summer of 1981, a new school of 1800 m^2 was built, which incorporated many energy conservation features. The project demonstrates the technical and ecomomic viability of recovering the waste heat produced by the community's generator motors and using it to almost totally heat the school. Of the three diesel-electric generators which handle the total power supply for Lac La Martre, two (281 kVa and 187 kVa capacity) have been connected to the heat recovery system. The school is provided with two 159 kW capacity boilers which are sized to handle the complete heating load. The system is described, including the heat exchangers, the heat pipe between the power plant and the school, the circulating pumps and the heat metering system. Preliminary load calculations revealed the need to use both the waste heat from the generator's coolant water and the flue gas. Now that the school has operated through a whole winter season, the project can be considered a success up to this point. From an intial capital outlay of Canadian $250,000, savings for fuel of Canadian 26,000/y are now being realized, with a total payback period of 9 years. However, it must be recognized that this system requires a higher level of skill to maintain than a simple on-off system. The difficulties encountered with a similar heat recovery system which was built in Igloolik during the 1970's are briefly discussed. 45 figs., 7 tabs.

28318 (NEI-FI–90, pp. 9) **District heating in Saarijaervi.** Mykkaenen, E. (Saarijaerven Kaukolaempoe Oy, Saarijaervi (Finland)). Valtion Teknillinen Tutkimuskeskus, Jyvaeskylae (Finland). Kotimaisten Polttoaineiden Lab. 1989. (In Finnish). (CONF-8901185–: Seminar on Energy meeting in Middle-Finland '89: energy and society, Jyvaeskylae (Finland), 19 Jan 1989). In *Energy Meeting in Middle-Finland 89.* Order Number DE90706084. Available from NTIS (US Sales Only), PC A05/MF A01.

In the year 1982 an investigation was made of the potential district heating customers in Saarijaervi, needs for building of district heating network and district heating power plant based on utilization of domestic fuels. A new cost estimation was made in spring 1985. In the summer 1985 Saarijaerven Kaukolaempoe Oy made a decision for a power plant delivery contract. A site for power plant was bought later in the year 1985. A preliminary contract concerning domestic fuel fueled power plant was made with Sermet Oy in the summer 1986. The fluidized bed boiler plant was equipped with 250 m^3 bipartite scraper bottomed storage, two levelled disk screen, electric filter and dry ash system. A 350 m^3 hot-water reserve was also decided to be delivered. A final decision for delivery was made in spring 1987. The counted amortization time was 7-8 years. The delivery of automation was separated as another contract and Afora Oy was selected as supplier. The main purpose for high rate of automation was to maintain an unmanned operation. The total costs for power plant were estimated to be 10.39 million FIM, which was exceeded by approx. 4.4%.

28319 (NEI-FI–90, pp. 20) **Energy supply in Jyvaeskylae.** Vaekiparta, J. (Jyvaeskylaen Energialaitos, Jyvaeskylae (Finland)). Valtion Teknillinen Tutkimuskeskus, Jyvaeskylae (Finland). Kotimaisten Polttoaineiden Lab. 1989. (In Finnish). (CONF-8901185–: Seminar on Energy meeting in Middle-Finland '89: energy and society, Jyvaeskylae (Finland), 19 Jan 1989). In *Energy Meeting in Middle-Finland 89.* Order Number DE90706084. Available from NTIS (US Sales Only), PC A05/MF A01.

The author reviews the development and the present situation of district heating in Jyvaeskylae as well as the future development. The reasons which led to building of Rauhalahti peat fueled power

plant have also been described. In this presentation there is also a short overview on experiences of the Rauhalahti power plant.

28320 (PB–90-154832/XAB) **Municipal-waste combustors - background information for proposed standards.** Radian Corp., Research Triangle Park, NC (USA). Aug 1989. 1237p. Available from NTIS, PC EE99/MF E99.

Set includes PB–90-154840 through PB–90-154881.

A separate abstract is included for each of the 5 volumes of this set.

28321 (PB–90-154840/XAB) **Municipal-waste combustors - background information for proposed standards: cost procedures. Volume 1. Final report.** Radian Corp., Research Triangle Park, NC (USA). 14 Aug 1989. 156p. Available from NTIS, PC A08/MF A01.

See also Volume 2, PB–90-154857; Also available in set of 5 reports PC E99/MF E99, PB–90-154832.

Cost Procedures for the costing of new and existing municipal waste combustor facilities and associated equipment are presented. Cost procedures are developed for combustors, heat recovery equipment, humidification equipment, air pollution control devices for the reduction of particulate matter and acid gas emissions, and continuous emission monitoring equipment. Costs in the report are divided into capital costs, operating and maintenance costs, and annualized costs. Costs associated with retrofitting existing facilities are also presented.

28322 (PB–90-154857/XAB) **Municipal-waste combustors - background information for proposed standards: 111(b) model plant description and cost report. Volume 2. Final report.** Radian Corp., Research Triangle Park, NC (USA). 14 Aug 1989. 130p. Available from NTIS, PC A07/MF A01.

See also Volume 1, PB–90-154840 and Volume 3, PB–90-154865; Also available in set of 5 reports PC E99/MF E99, PB–90-154832.

Twelve model plants are developed to represent the projected municipal waste combustor (MWC) industry. The model plants selected represent new MWC's expected to be constructed in the United States between 1990 and 1994. The model plants differ with respect to unit size and design, waste feed characteristics, heat recovery method, and flue gas emissions. The model plants provide a basis for estimating emission reductions, costs, and other impacts for various control alternatives. Information is provided on capital and operating and maintenance (O&M) costs of the model plants and control equipment.

28323 (PB–90-154865/XAB) **Municipal waste combustors-background information for proposed standards: Post-combustion technology performance. Volume 3. Final report.** Radian Corp., Research Triangle Park, NC (USA). 22 Sep 1989. 317p. Available from NTIS, PC A14/MF A02.

See also Volume 2, PB–90-154857 and Volume 4, PB–90-154873; Also available in set of 5 reports PC E99/MF E99, PB–90-154832.

The document evaluates the performance of various air pollution control devices applied to new and existing municipal waste combustors (MWC's). The control devices analyzed include electrostatic precipitators (ESP's), furnace sorbent injection systems with ESP's, moderate- and low-temperature duct sorbent injection systems with ESP's, or fabric filters (FF's) and spray dryers with ESP's or FF's. The removal capabilities for each of these control devices are evaluated for particulate matter, metals (arsenic, cadmium, chromium, lead, mercury, and nickel), chlorinated dibenzo-p-dioxins and dibenzofurans, and acid gases, sulfur dioxide and hydrogen chloride.

28324 (PB–90-154873/XAB) **Municipal-waste combustors - background information for proposed standards: Control of NOx emissions. Volume 4. Final report.** Radian Corp., Research Triangle Park, NC (USA). 14 Aug 1989. 113p. Available from NTIS, PC A06/MF A01.

See also Volume 3, PB–90-154865 and Volume 5, PB–90-154881; Also available in set of 5 reports PC E99/MF E 99, PB–90-154832.

The report characterizes nitrogen oxide (NO_x) emissions from municipal waste combustors (MWC's) and assesses the performance and costs associated with controlling NO_x emissions. Available data on NO_x emissions from MWC's are summarized. Various control technologies for reducing NO_x emissions, both combustion modifications and add-on controls, are reviewed. Performance data and operational experience for NO_x controls which have been applied to MWC's are presented. Cost algorithms are developed for Thermal De(NO_x), one of the add-on control technologies that has been applied to several new MWC's. The cost algorithms for Thermal De(NO_x) are used to estimate annualized NO_x control costs and cost-effectiveness values for twelve model plants representative of new MWC's.

28325 (PB–90-154881/XAB) **Municipal-waste combustors - background information for proposed guidelines for existing facilities. Volume 5. Final report.** Radian Corp., Research Triangle Park, NC (USA). 14 Aug 1989. 521p. (DCN–89-239-003-46-14). Available from NTIS, PC A22/MF A03.

See also Volume 4, PB–90-154873; Also available in set of 5 reports, PC E99/MF E99, PB–90-154832.

Major categories of existing municipal waste combustor facilities are identified. Representative model plants are identified and serve as the basis of the evaluations presented. The technical feasibility, environmental benefits, and cost impacts of various retrofit options are presented for each of the model plants.

28326 (PB–90-154899/XAB) **Economic impact of air-pollutant emission guidelines for existing municipal-waste combustors. Final report.** Morris, G.E.; Jellicorse, B.L.; Heller, K.B.; Neely, P.T.; Bingham, T.H. Research Triangle Inst., Research Triangle Park, NC (USA). Center for Economics Research. Aug 1989. 168p. Available from NTIS, PC A08/MF A01.

Errata sheet inserted. See also PB–90-154907.

The U.S. Environmental Protection Agency (EPA) plans to propose new air pollution emission guidelines for approximately 200 municipal waste combustors (MWCs) in late 1989. The regulations will significantly affect the cost of owning and operating these MWC plants. Affected plants include both currently operating plants and those plants under construction when regulations are proposed in the Federal Register. The report uses three economic scenarios to examine the economic impact of the five regulatory alternatives under most active consideration by EPA.

28327 (PB–90-154907/XAB) **Economic impact of air-pollutant emission standards for new municipal-waste combustors. Final report.** Morris, G.E.; Jellicorse, B.L.; Heller, K.B.; Neely, P.T.; Bingham, T.H. Research Triangle Inst., Research Triangle Park, NC (USA). Center for Economics Research. Aug 1989. 166p. Available from NTIS, PC A08/MF A01.

Errata sheet inserted. See also PB–90-154899.

The U.S. Environmental Protection Agency (EPA) plans to propose New Source Performance Standards (NSPSs) for air emissions from new municipal waste combustors (MWCs) in late 1989. Affected plants include all MWC plants that are placed under construction after regulations are proposed in the Federal Register. The regulations will affect the number of plants built and the combustion technology selected. The regulations will also significantly affect the cost of owning and operating these new plants. The report uses three economic scenarios to examine the economic impact of the five regulatory alternatives under most active consideration by EPA.

28328 (PB–90-159666/XAB) **Municipal solid-waste-management options.** Envirodyne Engineers, Inc., Chicago, IL (USA). Jun 1989. 443p. Available from NTIS, PC EE99/MF E99.

Set includes PB–90-159674 through PB–90-159708.

A separate abstract is included here for Volumes 3 and 4 of this set.

28329 (PB–90-159690/XAB) **Municipal solid-waste-management options. Volume 3. Transfer stations.** Bawkon, B. Envirodyne Engineers, Inc., Chicago, IL (USA). Jun 1989. 59p. Available from NTIS, PC A04/MF A01.

See also Volume 2, PB–90-159682 and Volume 4, PB–90-159708; Also available in set of 4 reports PC E99, PB–90-159666.

Transfer stations are facilities where solid waste is transferred from collection trucks to larger haul vehicles for transport to disposal sites. In places where disposal sites are distant from collection areas, this can be an effective means of lowering costs and improving the efficiency of a waste hauling and disposal system. They provide a central location between collection and disposal points to store and process waste for more efficient transport. It allows for fuller utilization of vehicles and collection crews; route organization is simplified; the impacts to roads on truck routes are minimized; traffic congestion can be minimized; and landfill operations are improved. Sometimes transfer stations include other processes such as shredding, baling, compacting, sorting, or recycling. This further reduces waste volume and can generate revenues from sale of recyclable materials, reduce costs for landfill disposal, and reduced transportation costs.

28330 (PB–90-159708/XAB) **Municipal solid-waste-management options. Volume 4. Waste-to-energy.** Bawkon, B. Envirodyne Engineers, Inc., Chicago, IL (USA). Jun 1989. 118p. Available from NTIS, PC A06/MF A01.

See also Volume 3, PB–90-159690; Also available in set of 4 reports PC E99, PB–90-159666.

The report describes the basic components and technology associated with combustion of municipal solid waste for recovery of energy. The report addresses the role of waste-to-energy in the overall solid waste management system that includes other types of disposal facilities, state and federal regulations, and the contractual relationships between project developer, owner, and participants.

28331 (PB–90-161001/XAB) **Municipal-waste combustion assessment: Waste co-firing. Final report, October 1988–July 1989.** Landrum, V.J.; Schindler, P.J. Energy and Environmental Research Corp., Durham, NC (USA). Jul 1989. 43p. Available from NTIS, PC A03/MF A01.

The report is an overview of waste co-firing and auxiliary fuel fired technology and identifies the extent to which co-firing and auxiliary fuel firing are practiced. Waste co-firing is defined as the combustion of wastes (e.g., sewage sludge, medical waste, wood waste, and agricultural waste) in a unit designed to burn municipal solid waste (MSW) or refuse derived fuel (RDF) as a major fraction of total fuel input. Auxiliary fuel firing is defined as firing coal, fuel oil, or natural gas in a municipal waste combustor under conditions when waste feed quantities are interrupted. This is a fairly common practice for dedicated RDF boilers, and there may be additional mass burn MWCs that meet the definition of auxiliary fuel firing. The report describes technologies used by facilities that meet these definitions, characterizes the population, and discusses design and operating practices and available emissions data from each facility. The report concludes with a discussion of recommended good combustion practices for waste co-firing combustors and auxiliary fuel fired MWCs.

28332 (PB–90-164054/XAB) **Municipal waste combustion assessment: Fluidized bed combustion. Final report, October 1988–July 1989.** Nelson, L.P. Energy and Environmental Research Corp., Durham, NC (USA). Jul 1989. 49p. Available from NTIS, PC A03/MF A01.

The report documents the results of an assessment of fluidized bed combustors (FBCs) to minimize air emissions from municipal waste combustors (MWCs). Objectives of the assessment were to identify the population of existing and planned refuse fired FBC facilities in the U.S., examine the design characteristics and operating practices employed, define representative model plants, and develop recommendations for implementing good combustion practices (GCPs) for the control of organic emissions from FBCs. The report describes the FBC configurations currently used and projected for use in refuse firing applications. It gives operating and emissions data for the two existing U.S. facilities and one Swedish circulating bed plant.

28333 (PJM–CE02952, pp. 71-76, Paper 12) **Case study: Modular controlled air incineration of municipal waste for energy recovery: The Prince Edward Island experience.** Hiscock, A.J. (Prince Edward Island Energy Corp. Charlottetown, PE (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This paper describes an municipal energy-from-waste system designed by Tricil, Inc. to supply steam to two hospitals in Charlottetown, P.E.I. P.E.I. currently relies on expensive imported oil for its energy needs. The principal operation of the design system employs a combination of partial pyrolysis and partial combustion in the primary chamber followed by complete combusion in a secondary chamber. Temperatures are controlled at approximately 760^0 C in the primary chamber and 900^0 in the secondary chamber. Inert ash is ejected into a wet-ash tank and finally removed to storage and ultimate landfill disposal. The capital cost of the project is $9.9 million. A federal grant provided $4 million. Operating costs in 1984 dollars are expected to be $900,000/y. Total revenue is projected to be $1,060,000/y. This revenue is insufficient to cover the long term debt but it is expected to reach a positive cash position by year 15.

28334 (PJM–CE02952, pp. 66-7, Paper 11) **Putting resource recovery into perspective.** Kennedy, J. (Tricil Waste Management Ltd., (Canada)); Topley, A. Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

Municipal solid waste (MSW) is generated at a rate of 1,200 pounds per capita per year. It has an energy value of 4,500 BTUs per pound. Although energy-from-waste systems are common in places like Japan and Denmark they have a low utilization rate in North America. Costs of alternative waste treatment systems, public awareness of environmental issues, improved process economics, and government support are strong incentives for construction of these systems. Lack of capable proponents, complexity of contractual arrangements, government regulation practices, energy price uncertainty, financing costs, and the newness of the technology are the principal deterrents. A semi-suspension waste burning boiler system utilizing a travelling grate installed in Hamilton, Ontario is described. Mass-burning of waste is also described. In a typical mass burning system fuel comes in at the start and forms a plug which gradually slides down into the furnace. The drying zone, combustion zone, and ash removal zone are comprised of reciprocating grates which continually churn the refuse forward. The maintenance of an oxidizing atmosphere in mass burning systems is a problem. A third system which does not involve metal removal is described briefly.

28335 (PJM–CE02952, pp. 30-36, Paper 6) **Getting energy from municipal solid waste off the ground: Breaking the financing barrier.** Sud, S.K. (Ontario Ministry of Energy, Toronto, ON (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy.* Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

By the year 2,000 Ontario is expected to produce enough municipal waste to supply about 0.7% of primary energy requirements. Waste-to-energy systems can supply a small but significant portion of total energy needs. For a waste-to-energy project to succeed it must use proven technology such as mass burning integral systems, or modular systems; the process economics must be sound; and the financing and ownership of the project must be established prior to start up. That is, long and short term financing for the project must be in place. Current process economics suggest a 15-18% return on capital given the right combination of high plant utilization, steam price, and tipping fees. There appear to be no economy-of-scale advantages. Financing incentives provided by programs like the Forest Industry Renewable Energy program are important. Financing of these projects is complex because of the number of stake holders. Typical projects involve the federal government, the provincial government, municipal government, energy

customers, equipment suppliers, plant operators, the bank or financing source, and the plant owner. A financial advisor should be involved at the feasibility study stage. A stable long term market for the energy is required. Financing should be feasible at current interest rates. It should include anticipated inflation during the construction period, contingency funds, underwriting and legal costs as well as the engineered cost estimates. Experience in financing of the Victoria Hospital energy-from-waste plant in London, Ontario is described as an example. 3 figs., 1 tab.

28336 (SEMR–11) **Energy audit: Luseland Recreation Centre; retrofit of recreation facilities project - phase 1: Final report.** Saskatchewan Dept. of Energy and Mines, Regina, SK (Canada). [1984]. 43p. (CE–02929). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

In the spring of 1982, Saskmont Engineering Company Limited conducted an energy audit of the Recreaton Centre in Luseland, Saskatchewan. The results of that audit are summarized herein. The Recreation Centre is now designated a Heritage Building. The building remained basically unchanged since it was originally built in 1926 as a four classroom schoolhouse. Total approximate floor area was 8300 sq. ft., including two main floors, basement, and attic area. A simple one pipe gravity steam radiation system provided heat in the building. The original coal-fired boiler has been converted to burn natural gas. The building is in very poor shape due to years of neglect. The windows were broken or missing, wind blows through the structure, the boiler was obsolete and inefficient, the control system is obsolete and causes overheating and underheating. The exterior of the building and foundation of the building appeared in reasonable shape but the interior building finishes had deteriorated to the point where total renovation of the building is required. In addition, the building would not meet present fire protection standards. There ar no fire separators. Fire exits were below standard and in some cases impassable or dangerous to use. There were no fire extinguishers evident in the building. Summarized are the implementation costs, energy saving, dollar saving and payback period of the energy conservation measures proposed in this report. Actual total savings may be less than the sum of the individual returns since some measures diminish the return yielded by others. 6 figs., 3 tabs.

28337 (STEV-TORV–90-1) **Peatland transportation: The Finn peatbog, borough of Surahammar, Sweden.** Jonsson, G. (Geo-Projektering Konsult AB, Uppsala (SE)); Komarek, R. Statens Energiverk, Stockholm (Sweden). Dec 1989. 36p. (In Swedish). Project STEV-146-148. Order Number DE90770850. Available from NTIS (US Sales Only), PC A03/MF A01.

The purpose of the project has been to develop a new technology for constructing useful transportation roads on peatbogs. In the present phase full scale tests have been carried out on various tests surfaces at the Finn peatbog near Surahammar, Sweden. The purpose of the tests has been to study machine technique, mixing technique, the effect of chemicals on the peat.

28338 (STEV-VK–89-4) **Preparatory projecting of power production at the Djuped plant.** Statens Energiverk, Stockholm (Sweden). 18 Aug 1989. 27p. (In Swedish). Project STEV-567-050. Order Number DE90770847. Available from NTIS (US Sales Only), PC A03/MF A01.

The possibility of power production at Hudiksvall has been studied. The Djuped plant covers today a district heating requirement of 150 GWh yearly. 80-85 % of the heat is produced in a 40 MW peat fueled heating boiler. This heat basis corresponds to 13-15 MW back pressure power, i.e. 50 GWh electric power yearly. A rebuilding of the present plant for combined heat/power production has been analysed. The total investment is estimated at MSEK 94.

28339 (SVF–355) **Remote analysis of substations.** Marklund, J. (Energiteknisk Utveckling AB, Trosa (Sweden)). Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden). Oct 1989. 65p. (In Swedish). Order Number DE90770841. Available from NTIS (US Sales Only), PC A04/MF A01.

The report describes a method of automatic analysis of substations in a district heating system. The method of analysis utilize an on-line remote reading system. The data is continuously collected from the substations and arranged in a computer. The collected data from the substations are energy- and volume pulses from the heating volume indicator. Necessary additional data (central collection): * The temperature for the exterior air, * The time day and night. After arranging the information, common error can be stipulated. Such errors are faulty distributing valve, fouled heat exchanger etc. The method can distinguish in which circuit the error is situated. The malfunction is discovered by using the connection between cooling refrigeration and outdoor temperature and the difference in load characteristics between radiator and hot water system during day and night. With the method of analysis it is consequently possible to fast find the reason of bad cooling refrigeration in a substation. The method can be transmitted to an applicable computer programme for documentary analysis on a municipal heating network. (author).

28340 (UBA-FB–89-30) **Assessment of sewage sludge treatment processes for the purpose of determining technical operating parameters.** Umweltbundesamt - Texte. Gehring, H.; Lang, A. Umweltbundesamt, Berlin (Germany, F.R.); Hoenheim Univ., Stuttgart (Germany, F.R.). Inst. fuer Tiermedizin und Tierhygiene mit Tierklinik. 1989. 304p. (In German). Contract UFOPLAN-Nr. 10303215. Available from Copy held by UB/TIB Hannover.

Using survey investigations for enterobacteriaceae, coliforms, salmonella, faecal streptococci, f-specific bacteriophagi, enteric virus and parasitic developmental studies the epidemic-hygienic consistency of crude and treated sludges from 24 conventionally operated sewage treatment plants was determined. The results of these studies also provided information about the frequency of occurrences of potential indicator organisms. The microorganisms found were examined for their temperature and ph-resistance to check their suitability as epidemic-hygienic indicators. In this fashion the following parameters were found which can serve for the epidemic-hygienic evaluation of sewage sludge: According to results of laboratory studies, sewage sludge can be considered harmless (1) if it contains not more than 1000 entero bacteriaceae/g, (2) if it contains no salmonella and (3) if it contains no contagious worm eggs. These parameters according to results of laboratory studies also apply to enteric viruses. The parameters also serve in concluding examinations to check some of the practically operated, generally accepted decontamination processes with respect to their epidemic-hygienic efficiency. In this respect it was ascertained that, if properly operated, the processes are basically able to produce epidemically and hygienically harmless sewage sludge. (orig./EF).

28341 (VTT-SYMP–103, pp. 171-180) **Substitution of hazardous materials in household and industrial products.** Christianse, K. (Technological Institute, Copenhagen (Denmark)); Hansen, E. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

The use and waste disposal of household and industrial products containing hazardous materials, e.g. cadmium or CFC, have introduced major environmental problems to the industrial society and the global ecosystem. Substitution of such hazardous constituents is a major goal for the preventive environmental technologies - the cleaner technologies. From a general listing and discussion of hazardous products in the context of waste management and disposal the possibilities of substitution of cadmium as a pigment and stabilizer in plastics and of CFC in numerous products are enlightened. Danish authorities and research institutions are together with industry and consultants going through substitution problems of other products and materials too, e.g. mercury and PVC. Beside economic restrictions, also lack of knowledge about technological possibilities plays a crucial role for the typical small Danish company. Adding to this lack of information about toxicology of the alternatives and inadequate evaluation of mass balances and priorities gives a complicated task for all of us.

3209 Education and Public Relations

Refer also to citation(s) 27796

33 ADVANCED PROPULSION SYSTEMS

3301 Internal Combustion Engines

Refer also to citation(s) 27487, 27579

28342 (Juel–2267) **Towards the methanol engine.** Heitland, H.H.; Hoffmann, H.J. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Forschungsgruppe Wirtschaft, Energie, Investitionen. Mar 1989. 103p. (In German). Order Number DE90779852. Available from NTIS (US Sales Only), PC A06/MF A01.

In addition to environmental aspects, the use of fuels produced on a domestic raw-material basis has a considerable strategic-political significance (crude oil imports) for many countries. Reports are presented on the development potential of future alcohol-driven engines in competition with petroleum-driven engines, and solutions for the transition from petroleum to methyl alcohol are presented. First of all, the possible development of the private car stock in the next century as well as the engines and fuels of today are considered. Then the development potential of today's Otto and diesel engines are discussed as well as the possibilities and limitations of alternative drive conceptions and the development potential of alcohol-driven vehicles. In conclusion the strategies of introduction for alcohol-driven vehicles are mentioned. (HWJ).

28343 (LA-UR–89-4275) **Evaluating thermographic phosphors in an operating turbine engine.** Noel, B.W. (Los Alamos National Lab., NM (USA)); Borella, H.M.; Lewis, W.; Turley, W.D.; Beshears, D.L.; Capps, G.J.; Cates, M.R.; Muhs, J.D.; Tobin, K.W. Los Alamos National Lab., NM (USA). [1989]. 13p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-900615–2: 35. international gas turbine and aeroengine congress and exposition (TURBO Expo), Brussels (Belgium), 11-14 Jun 1990). Order Number DE90004874. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The results of a field test in a commercial turbine engine showed that we can remotely measure the temperature of engine components in operating engines using thermographic phosphors. The remote- measurement method exploits the temperature dependence of the characteristic decay time of the laser-induced fluorescence of thermographic phosphors. This paper summarizes recent work leading up to and including a successful test of the thermographic-phosphor method in an operating turbine engine. 6 refs., 7 figs.

28344 (ORNL/FMP–89/2, pp. 447-465) **NIST-3 - Mechanisms of galling and abrasive wear.** Ives, L.K. (National Institute of Standards and Technology, Gaithersburg, MD (USA)); Whitenton, E.P.; Strakna, T. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The successful commercial development of direct coal-fueled diesel engines depends on solving severe wear problems that are not encountered with present day oil-fueled engines. The purpose of this program is to develop a fundamental understanding of the processes and mechanisms that are responsible for wear at the critical piston ring/cylinder wall contact. In this report the results of laboratory wear test investigations of several different types of particles in lubricating oil are presented and discussed.

28345 (PB–90-151150/XAB) **Advanced gas prime-mover concepts. Topical report, March 1987-June 1988.** Mathis, R.; Wood, C.; Urban, C.; O'Neal, G.; King, S. Southwest Research Inst., San Antonio, TX (USA). Jul 1988. 137p. Available from NTIS, PC A07/MF A01.

See also PB–90-151143.

The project acquired and disseminated gas engine technology to users, manufacturers, and suppliers of gas-fueled engines; provided the means by which novel gas engine concepts can be quickly evaluated for feasibility, and determined the technical feasibility of an injector/igniter system designed to permit unthrottled operation of gas engines without the requirement for a high pressure gas compressor for fuel injection. Seven concepts were evaluated; five were investigated analytically, and two were investigated using single-cylinder test engines. The concepts investigated were: a gas pilot injection system to improve the ignition and combustion of a lean fuel-air mixture (thereby improving thermal efficiency, reduce NOx emissions and knock sensitivity), the feasibility of a catalytic glow plus, the feasibility of using a by-chamber in rotary engines, compression ignition of a homogeneous mixture of natural gas and air, a ringless piston and sealless rotor engine, fuel stratification in a rotary engine, and the improvement of combustion efficiency of gas-fueled engines using an advanced injection and ignition system technique.

28346 (UCRL–102784) **A comparison of the autoignition chemistry of n-butane and isobutane in an internal combustion engine.** Wilk, R.D.; Green, R.M.; Pitz, W.J.; Westbrook, C.K.; Addagarla, S.; Miller, D.L.; Cernansky, N.P. Lawrence Livermore National Lab., CA (USA). [1990]. 19p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-48. (CONF-900282–3: Annual Society of Acoustical Engineers congress, Detroit, MI (USA), 26 Feb - 2 mar 1990). Order Number DE90009474. Available from NTIS, PC A03/MF A01 - OSTI.

Butane is the simplest alkane fuel for which more than a single structural isomer is possible. In the present study, n-butane and isobutane are used in a test engine to examine the importance of molecular structure in determining knock tendency, and the experimental results are interpreted using a detailed chemical kinetic model. A sampling valve was used to extract reacting gases from the combustion chamber of the engine. Samples were withdrawn at different times during the engine cycle, providing concentration histories of a wide variety of reactant, olefin, carbonyl, and other intermediate and product species. The chemical kinetic model predicted the formation of all the intermediate species measured in the experiments. The agreement between the measured and predicted values is mixed and is discussed. Calculations show that RO_2 isomerization reactions are more important contributors to chain branching in the oxidation of n-butane than in isobutane. Chain branching in isobutane oxidation is dependent on H-atom abstraction reactions involving HO_2 and CH_3O_2 radicals that occur at higher temperatures than RO_2 isomerization reactions. Therefore, an isobutane mixture must be raised to a higher temperature than a n-butane mixture to achieve the same overall rate of reaction. 33 refs., 6 figs., 2 tabs.

28347 **The influence of fluid motion on flame kernel development and cyclic variation in a spark ignition engine.** Hall, M.J. (Combustion Applications Div., Sandia National Labs, Livermore, CA (US)). 14p. Society of Automotive Engineers, Warrendale, PA (USA) (1989). (CONF-8904240–: 40. Society of Automotive Engineers annual earthmoving industry conference, Peoria, IL (USA), 11-13 Apr 1989).

Paper 890991.

The author reports on examination of the effect of engine flow field characteristics on cycle-to-cycle variation in a methane fueled engine. The rate of early flame development was correlated with the turbulence characteristics and the mean flow. This, in turn, was correlated with engine performance characteristics such as peak cylinder pressure. Drastically different flow field characteristics were achieved in the engine through the use of a prechamber having a variable inlet orifice diameter. Three combustion chamber geometries were examined: main chamber combustion without a prechamber, a prechamber with a 27 mm entrance orifice. Measurements of mean velocity and turbulence intensity were made in the region of the spark using laser Doppler velocimetry. The engine had a compression ratio of 5.1 and was operated at speeds of 300, 600, and 1200 rpm. The equivalence ratios were 0.7 and 0.8. A newly developed fiber optic spark plug probe was used to measure early flame development. It was found that the rate of early flame development increased with increasing turbulence intensity. It was determined that for lean operation, the development of the early flame is critical to subsequent combustion. Under most operating conditions a strong correlation was found between how

quickly the flame grew to a diameter of 1 cm and the peak cylinder pressure and crank angle of peak cylinder pressure.

28348 Cooper-Bessemer coal-fueled engine system: Progress report. Rao, A.K. (Cooper-Bessemer Reciprocating, Grove City, PA (US)); Wilson, R.P. Jr.; Balles, E.N.; Mayville, R.A.; McMillian, M.H.; Kimberley, J.A. *Journal of Engineering for Gas Turbines and Power (USA)*, 111(3): 489-506 (Jul 1989).

Single-cylinder engine tests were conducted as part of a long-range effort to develop a technology base for coal-fueled stationary modular power plants based on the Cooper-Bessemer LS Series four-stroke diesel engine. These engine test results established the new state of development for this technology as well as setting priorities for the remaining R and D effort on specific components. The current outlook on the overall economics of coal diesel power is presented, including that CWS processing cost dominates the question of economic feasibility. A description of the coal-tolerant fuel injection system development is also given. Wear results indicate that nozzle erosion is the critical element in extending the duration of continuous engine operation. Substantial nozzle wear was observed in just two hours of CWS operation. The ash content of the coal was found to affect the wear rate of the ring set as well as the nozzle tip. Combustion results indicate that the natural gas jet cell is a viable ignition aid and that the variable area poppet nozzle, which lends itself to the use of durable coatings, provides satisfactory engine performance.

28349 Piston ring thermal transient effects on lubricant temperatures in advanced engines. Boisclair, M.E. (Sloan Automotive Lab., Massachusetts Institute of Technology, Cambridge, MA (US)); Hoult, D.P.; Wong, V.W. *Journal of Engineering for Gas Turbines and Power (USA)*, 111(3): 543-552 (Jul 1989).

One class of advanced diesel engines operates with low heat rejection and high operating temperatures; piston-ring/linear lubrication is a major problem for these engines. This study attempts to illustrate the time-dependent thermal environment around the top piston ring and lubricant in these advanced engines. Particular emphasis is passed on the maximum lubricant temperature. The analysis starts with a standard cycle simulation and a global finite-element analysis of the piston and liner in relative motion. A more detailed finite-element model, which considers variable oil film thickness on the linear, focuses on the top ring and lubricant and uses the grove and linear temperatures generated in the global analysis as boundary conditions. Results for different heat rejection engine configurations are presented. The authors observe that because of major transient effects, high lubricant temperature is experienced not only at top ring reversal but also down the linear to bottom ring reversal.

28350 Internal dynamic force analysis for V-type engine/compressor with articulated power cylinder connecting rod mechanism. Doughty, S. (Univ. of Wisconsin-Platteville, Platteville, WI (US)); Smalley, A.J.; Evans, B.F. *Journal of Engineering for Gas Turbines and Power (USA)*, 111(3): 530-535 (Jul 1989).

This paper presents a systematic analysis of the internal dynamic forces within a V-engine/compressor with articulated power cylinders. All inertial terms are included in the formulation, which is solvable for the crankshaft torque and all reactions. After formulating the necessary description, the results are applied to two case studies involving pipeline compressor units.

28351 Component wear in coal-fueled diesel engines. Flynn, P.L. (GE Transportation Systems, Erie, PA (US)); Leonard, G.L.; Mehan, R.L. *Journal of Engineering for Gas Turbines and Power (USA)*, 111(3): 521-529 (Jul 1989).

Practical use of coal-fueled diesel engines depends on the improvement of component durability. The wear characteristics of standard materials in the coal-fueled engine were studied first. Candidate wear-resistant materials were sorted by bench-scale tests. The best material combinations were applied to small-scale engine tests for operation on seeded diesel fuel. Components with hard materials and coatings were scaled up for coal-water mixture testing on the locomotive engine. Results indicate practical solutions for ring and liner wear and positive progress toward defining the material requirements for the fuel injection nozzle.

3302 External Combustion Engines

28352 (LUTMDN-TMVK–5179-1-120-1989) **Stress and fatigue analysis of the Stirling engine SCP 1-75 cylinder head.** Bjoerklund, T; Fridolfsson, P. Lund Univ. (Sweden). Dept. of Heat and Power Engineering. Nov 1989. 122p. (In Swedish). Order Number DE90770865. Available from NTIS (US Sales Only), PC A06/MF A01.

Examination paper.

A strength analysis was done by means of a finite element program of the cylinder head. Both the geometric shape and the choice of material was studied. With the original geometry the estimated stress concentrations will be up to 750 N/mm^2 at a maximum cylinder pressure of 12.5 Mp. The true maximum stresses will of course be lower because of material yield. They are however not acceptable neither with the original, cheaper material Incology 800 nor with a more qualified material like XF-818. This means that changes of the geometry are needed. It is shown that the highest stress concentrations may be reduced to a level of 430 N/mm^2 by minor geometric modifications. Also substantially different configurations were investigated. It turned out possible further decrease the stresses, caused by the inner overpressure, by designing the cylinder head as a pressure vessel with well forms. The cylinder head design should also allow a uniform temperature distribution to restrain the predominating thermal stresses. (102 figs.).

3303 Electric-Powered Systems

Refer also to citation(s) 28108, 28109, 28221

3306 Vehicle Design Factors

Refer also to citation(s) 28345, 28367, 28744

28353 (PB–90-162215/XAB) **Direct gas injection with glow-plug ignition. Annual report, August 1988–July 1989.** Richards, B.G. Caterpillar, Inc., Peoria, IL (USA). Aug 1989. 59p. Available from NTIS, PC A04/MF A01.

See also PB–89-138606.

Feasibility demonstration tests on a direct injected natural gas Caterpillar 3400 Series single cylinder engine have successfully shown that natural gas engine specific power and thermal efficiency can be improved to levels equal to the diesel. Component design for a commercial Caterpillar 3500 Series DI natural gas engine is nearing completion and procurement for a single cylinder 3500 Series DI natural gas performance demonstration engine is being initiated. The hardware includes a gas injector, a cylinder head that incorporates an ignition-assist glow plug, and a piston. During the next work-year, effort will focus on completion of the hardware procurement and on demonstrating diesel power and thermal efficiency on a single cylinder 3500 Series DI natural gas engine.

3307 Emission Control

28354 (PB–90-161209/XAB) **Evaluation of resistively heated metal monolith catalytic converters on an M100 neat methanol-fueled vehicle. Part 2. Technical report.** Piotrowski, G.K. Environmental Protection Agency, Ann Arbor, MI (USA). Office of Mobile Sources. Dec 1989. 26p. (EPA/AA/CTAB–89/09). Available from NTIS, PC A03/MF A01.

See also Part 1, PB–89-101158.

Two catalyst formulations using resistively heated metal monolith substrates were evaluated for the application of exhaust emission catalysts on an M100 neat methanol-fueled vehicle. The active catalyst formulations were palladium: cerium (Pd:Ce) and a base metal formulation. The catalysts were evaluated at low mileage in two modes: Resistive heating applied to the substrate during portions of the cold-start and hot-start transient segments of the test cycle (Federal test procedure); and No resistive heating applied to the substrate during the driving cycle. The test vehicle was also driven in the baseline, or no-catalyst mode, to obtain engine-out emission levels for comparison. Resistively heating the palladium catalyst provided a substantial emissions control benefit over the non-resistively heated catalyst mode. The base metal catalyst

showed a slight improvement in emissions when the catalyst was resistively heated.

28355 **Reduction of nitrogen oxides in engine exhaust gases by the addition of cyanuric acid.** Caton, J.A. (Texas A and M University, College Station, TX (US)); Siebers, D.L. *Journal of Engineering for Gas Turbines and Power (USA)*, 111(3): 387-393 (Jul 1989).

Nitric oxide concentrations in a portion of the exhaust of a diesel engine operated with equivalence ratios between 0.25 and 0.75 were reduced by up to 98 percent by the addition of cyanuric acid. The cyanuric acid was combined with the exhaust gas in an electrically heated quartz flow reactor. The effects of the key process parameters (temperature, exhaust gas composition and residence time, and the overall engine equivalence ratio) on NO reduction by cyanuric acid are reported. Nitric oxide reduction was evident at flow reactor temperatures above 700 K. The maximum nitric oxide reduction varied from 80 percent for a reactor temperature of 1180 K and an engine equivalence ratio of 0.25 to 98 percent for a temperature of 1120 K and an equivalence ratio of 0.75. The temperature range over which 60 percent or greater nitric oxide reduction was obtained was 1100 to 1340 K. Increasing the exhaust gas carbon monoxide concentration lowered the required reactor temperature and increased the temperature range for significant nitric oxide reduction. Increasing the exhaust gas nitric oxide concentration lowered the ratio of cyanuric acid to nitric oxide required for maximum nitric oxide reduction.

28356 **Environmental aspects of coal-fueled diesel engines.** Williams, M.C. (U.S. Department of Energy, Morgantown Energy Technology Center, Morgantown, WV (US)); Holcombe, N.T.; McMillian, M. *Journal of Engineering for Gas Turbines and Power (USA)*, 111(3): 491-497 (Jul 1989).

Conventional diesel engines are considered by some to be contributors to environmental problems since they emit NO_x, a suspected acid rain precursor. Initial testing has shown that CWS-fueled diesels emit substantially reduced NO_x emissions. While emissions of particulates and SO_x may be potentially higher with coal fuels, assessment of the control technology indicates excellent potential for meeting existing and future standards for these emissions. As a result of activities managed by the Morgantown Energy Technology Center, the economic and technical feasibility of CWS-fueled diesel engines has been determined. The development of CWS-fueled systems will necessitate the application of hot gas cleanup contaminant control technology to ensure that the systems burn coal in an environmentally sound manner. The objective of this paper is to discuss the environmental concerns, emission goals, and the control methodologies, devices, and strategies that will be used to ensure CWS-fueled diesel engines will meet current and potential environmental standards.

28357 **Coal-fueled diesels: Systems development.** McMillian, M.H. (U.S. Deptartment of Energy, Morgantown Energy Technology Center, Morgantown, WV (US)); Webb, H.A. *Journal of Engineering for Gas Turbines and Power (USA)*, 111(3): 485-490 (Jul 1989).

The U.S. Department of Energy (DOE) Office of Fossil Energy has sponsored research in the area of coal-fueled diesel engines since the late 1970s. The program began as an exploratory effort and has grown into a proof-of-concept program that includes several major medium-speed diesel engine manufacturers. Those manufacturers have identified the utility, industrial cogeneration, and transportation markets as areas in which expensive clean distillate fuel may be displaced by low-cost, domestically abundant coal. The development of coal fuels, engine components, wear and emission control system, and a support infrastructure. Because of success in earlier projects of the coal-fueled diesel program, the DOE's Morgantown Energy Technology Center (METC) recently expanded the program with the award of contracts for two 5-year, proof-of-concept project. These projects will build on the results of past work to complete development of technology for the commercialization of coal-fueled diesel engines. This paper summarizes progress in the DOE program and planned research to overcome technical and economic barriers to that commercialization.

3308 Alternative Fuels

Refer also to citation(s) 27487, 27950, 28155, 28346, 28347, 28353, 28354

28358 (CGA–CE02953, pp. 186-195) **NVG [Natural Gas for Vehicles] metering.** Simpson, D. (Union Gas Ltd., Chatham, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

The marketing of natural gas as a vehicle fuel has been growing steadily in Canada since its introduction less than 10 years ago. The safety, environmental, and financial advantage of natural gas for vehicles (NGV) make it a strong candidate as the alternative fuel of the future. Accompanied with the growth of the NGV market is the creation of a strong new demand for the design and implementation of NGV related equipment. From individual vehicle conversions to complete compressor station installations there is an extreme variety of both electronic and mechanical equipment required to maintain and operate a NGV program. These new technological demands present an excellent opportunity for Canadian manufacturers to take part in a new and upcoming industry. Properties of natural gas which make it safe for use in vehicles include the following: natural gas, which is lighter than air, rises and dissipates quickly if accidentally released, natural gas is transported via a safe undrground distribution system, natural gas has a higher ignition temperature and higher combustion limit than gasoline or propane, and finally natural gas burns cooler than these fuels. 5 refs.

28359 (PB–90-121922/XAB) **Study on methanol-fueled vehicle with an Otto-type engine.** Tsukasaki, Y.; Nohira, H.; Ito, S.; Inoue, T. Toyota Motor Co. Ltd., Aichi (Japan). c 1989. 9p. Available from NTIS, PC A06/MF A01.

Text in Japanese; Included in Toyota Engineering, Vol. 39, No. 1, 43-51(1989).

Methanol fuel utilization for van-type vehicles with Otto-type engines has been studied. A water-cooled, in-line four, 2 liter engine equipped with the multi-point fuel injection system was operated with near neat methanol fuel (M85). Spark plugs without platinum tipped electrodes and the 10.2 compression ratio were adopted to prevent preignition damaging the engine. Exhaust emission levels from a methanol fueled vehicle were almost equal to those of a gasoline vehicle under the 10-mode driving cycle, but HC and CO emissions under the 11 mode driving cycle were larger than those from a gasoline vehicle due to enriched mixture calibration during warm up condition. With regard to the durability, there still remains many problems to be resolved, for example, engine wear, oil dilution under short distance traveling conditions, the injector and the fuel pump malfunctions. Moreover, the formaldehyde emission increased with mileage.

28360 (SC/ORC–AF88-05) **A comparison of the durability of methanol and gasoline fuelled vehicles.** Mitchell, D.K. Shell Canada Ltd., Toronto, ON (Canada). Oakville Research Centre. Nov 1989. 42p. (MICROLOG–90-00948). Available from PC Ontario. Ministry of Transportation. Transportation Technology and Energy Branch, 1201 Wilson Ave., Downsview, ON, CAN M3M 1J8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN.

This report contains the conclusion of a long-term study of the engine durability of a group of methanol-fuelled Ford Escorts. These vehicles were part of a fleet specially developed by the manufacturer to run on a mixture of 85% methanol and 15% gasoline and supplied for evaluation. Alterations to the standard Escort included increased compression ratio of 11.8:1 and use of nickel-plated components throughout the fuel system. Five methanol-fuelled vehicles were compared with 2 gasoline fuelled Escorts. At the beginning of this test, 2 methanol and 2 gasoline vehicle engines were stripped and the dimensions of important wear-prone components recorded. Progress was monitored by periodically analyzing used engine oil for quality changes and wear

metal accumulation. The pre-measured engines were stripped at the end of the test to check actual component wear. During the test period, some higher levels of wear of metals were observed for the methanol-fuelled vehicles. Quality changes in the oil were comparable for the two fuels. Near the end of the test period, both methanol vehicles showed signs of deteriorating performance attributed to pre-ignition, a known problem with methanol engines. Comparision with the gasoline engines showed increased ring wear and less wear in bearing shells and camshaft lobes. The methanol engines showed lower sludge and engine deposits but greater carburetor deposits. The main conclusion is that this particular engine is vulnerable to pre-ignition damage, probably because it was not designed for the increased compression ratio. Design improvements would be needed to gain acceptable durabilitiy, particularly for the Canadian climate where engine wear is likely to be most severe. 6 refs., 15 figs., 21 tabs. Half a line too long.

28361 (SLU-IMB–40, pp. 183-190) **Biogas as a vehicle fuel.** Bernesson, S. (Sveriges Lantbruksuniv., Uppsala (SE). Inst. foer Lantbrukstekniik). Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish). (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

Biogas has many advantages as a fuel, no net production of carbon dioxide to the atmosphere, clean combustion, no carcinogenic emissions and a high octane number. Biogas can be used in both Otto engines and diesel engines. In Otto engines the cold starting characteristics is very good, you don't need to choke. Hence biogas can be a very good fuel for vehicles drived short distances in a cold climate. For Otto engines a petrol engine can be rebuilt to an gas engine with the possibility to drive on petrol left. The Otto engine can also be completely optimated for gas with a higher compression ratio and lower fuel consumption. This engine cannot drive on petrol. A diesel engine can be driven on biogas as a dual fuel engine. Diesel oil is pilot fuel and biogas is main fuel. The pilot fuel is injected to the cylinder to ignite the air/biogas mixture. Dual fuel engines can be driven with only a simple equipment for supplement with biogas in the suction manifold or a more advanced regulation system for optimal supplement with biogas at different speeds and loads. A diesel engine can also be rebuilt to an Otto engine. Biogas have been used in vehicles in many places. Both cars, lorries, buses and tractors have been tested with biogas fuel. It is important that you can offer the customers a good price of the gas which can be difficult today. The price of biogas today would relate a petrol price without tax of ca. SEK 1.70-2.00 per l. The petrol price of today without tax is SEK 1.74 per l.

28362 **Cold weather methanol vehicle demonstration fleet at Argonne National Laboratory: Implications for flexible fuel and dedicated methanol commercialization.** Volume 6. Saricks, C.L (Argonne National Lab, Argonne, IL (US)); Larsen, R.P. 11p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679–: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

Technical Paper 88-99.1.

The basis for introducing methanol vehicles into federal inventory included evaluation of vehicle performance under normal and cold weather conditions, assessment of fuel economy, emissions and safety, comparison of operations and maintenance costs, and establishment of refueling stations for public use. A primary goal of the project was to introduce and assimilate methanol-fueled vehicles within the federal fleet in a manner common to, and consistent with, the use of gasoline vehicles in that fleet. Methanol fleet operations began at Argonne National Laboratory (ANL) in early fall of 1986 with the delivery of five light-duty pickup trucks. Nine production gasoline-fueled control vehicles had already been delivered in late summer. The methanol fleet was augmented in December, 1986 by delivery of five methanol-converted cars, bringing the total vehicle population at ANL to 19. This paper describes the experience of over one full year of operation of the ANL fleet and its ancillary infrastructure (the refueling station, etc.), and offers conclusions based on this experience about the likely timing of and remaining obstacles to commercial production of methanol-capable vehicles.

35 ARMS CONTROL

Refer also to citation(s) 28157, 28158, 28159, 28160, 28161, 28162, 28163, 28164, 28165

28363 (AD-A–216865/6/XAB) **Post-INF: Toward multipolar deterrence.** Wendt, J.C.; Wilson, P.A. Rand Corp., Santa Monica, CA (USA). Feb 1988. 33p. (RAND/P–7407). Available from NTIS, PC A03/MF A01.

The NATO nations have never had enough conventional forces to deter the Soviets in Europe, and they have relied on NATO's nuclear forces–primarily American–for deterrence. As Soviet conventional and nuclear forces have grown larger and more threatening, the credibility of using U.S. nuclear forces in response to Soviet aggression in Europe has eroded. The decision to place U.S. Pershing II (PII) missiles and ground-launched cruise missiles (GLCMs) in Western Europe was intended to bolster this credibility. The intermediate nuclear forces agreement, which removes these missiles, although necessary for political reasons, is likely to further erode the credibility of the U.S. threat to use nuclear weapons in the defense of Europe. In the short run, some technical fixes could compensate somewhat for the removal of the PII and GLCM missiles. But, in the longer run, the current deterrence system, which relies on U.S. nuclear weapons to deter the Soviet Union, is likely to increasingly evolve toward a multipolar system including France, the United Kingdom and China, which possess growing nuclear arsenals playing a larger role in deterrence. Here we shall analyze the elements of deterrence and examine how U.S. nuclear forces have produced extended deterrence in Europe.

28364 (AD-A–216960/5/XAB) **Threat, the conventional balance, and arms control: The emerging alternative view in Europe.** Bitzinger, R.A. Rand Corp., Santa Monica, CA (USA). Sep 1988. 18p. (RAND/P–7488). Available from NTIS, PC A03/MF A01.

The 1980s has witnessed the emergence of a rather impressive peace faction in Western Europe. Although disparate, it has not been without its impact on the European debate over security policy. It has also not been without its own intellectuals, security experts and peace researchers, who in turn have had a growing influence on European politics, significantly in the mainstream social democratic and labor parties. This includes shaping opinions on the Soviet threat, on the conventional balance in Europe and on goals and proposals for conventional arms control, especially now in the wake of an agreement banning all intermediate-range nuclear forces (INF). This paper will attempt to synthesize the broad spectrum of thought revolving around the conventional balance and conventional arms control in Europe on the part of European peace advocates. It will ask, and attempt to answer, particular questions in this area, according to the selected writings of European peace researchers, activists and political partisans. These include: Whence is the threat to Europe. Is there a Soviet threat. What is their assessment of the balance in conventional forces in Europe between NATO and the Warsaw Pact, and is it relevant to the issue of the threat to Europe, or does something larger loom. What are their proposals for conventional arms control, and what are the underlying aims. In addition, particular attention will be paid to how peace researchers and international security analysts (such as those found in great abundance in places like RAND) differ greatly in their basic perceptions of the international order and in their basic goals and how this, in turn, colors their respective analyses and proposals.

3501 Policy, Negotiations, and Legislation

28365 (AD-A–216894/6/XAB) **Whither SDI (Strategic Defensive Initiative): Strategic defenses in the next administration.** Kanter, A. Rand Corp., Santa Monica, CA (USA). Sep 1988. 29p. (RAND/N–2806-RC). Available from NTIS, PC A03/MF A01.

This document examines the legacy of strategic defenses the next president will inherit from the Reagan administration. Concentrating on SDI, it describes the programmatic, budgetary, arms

control, and political contours of the strategic defense agenda that the new president is likely to confront. It then considers the options he will face and plots a course he should take. This essay is intended to stimulate and structure debate about the future of strategic defenses. An earlier version of this paper was prepared for a Council on Foreign Relations study group on the Arms Control Agenda of the Next Administration. Since it was initially drafted in spring 1988, the politics of SDI have changed with a speed that few could have predicted. Abruptly and unexpectedly, SDI all but disappeared from the political debate at precisely the time when a multitude of candidates were vying for their parties' nominations, and then the two nominees were seeking to define and distinguish their positions. Despite these changed circumstances, this document should be of interest to those who are concerned with how developments in strategic defense bear on nuclear policy, programs, and arms control.

28366 Fixing the nation's nuclear-weapons plants. Ahearne, J.F. (Dept. of Energy's Advisory Committee on Nuclear Facility Safety (US)). *Technology Review (USA)*, 92(5): 24-29 (Jul 1989).

This article addresses the problems facing U.S. nuclear weapons plants. The author describes the three oversight groups now monitoring defense reactors and discusses their effectiveness individually as well as in possible conflict with one another. Long-range problems including funding and lack of personnel, are also explored.

3503 Verification

Refer also to citation(s) 28972

36 MATERIALS

Refer also to citation(s) 27895, 28151, 28152, 28597, 28600, 28628

28367 (PB–90-859943/XAB) **Rust inhibiting coatings. January 1980-November 1989 (A Bibliography from World Surface Coatings Abstracts). Report for January 1980-November 1989.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 80p. Available from NTISPC N01/MF N01.

Supersedes PB–88-852603.

This bibliography contains citations and selected patents concerning coatings used to inhibit or prevent rust. Films, pigments, paints, resins, pastes, plastisols, cleaning liquids, and paper are examined for rust inhibiting characteristics. Coatings and rust prevention programs used on automobiles are emphasized. (This updated bibliography contains 198 citations, 35 of which are new entries to the previous edition.)

3601 Metals and Alloys

Refer also to citation(s) 27486, 27671, 27699, 27751, 27786, 27915, 27916, 27917, 27918, 27919, 27920, 27921, 27922, 27923, 27924, 27925, 27926, 27928, 27929, 27930, 27931, 27932, 27933, 27934, 27935, 27941, 27943, 27955, 27995, 27999, 28001, 28002, 28022, 28027, 28036, 28037, 28045, 28068, 28075, 28083, 28084, 28344, 28351, 28501, 28505, 28522, 28556, 28616, 28617, 28618, 28620, 28621, 28623, 28625, 28626, 28627, 28629, 28637, 28638, 28639, 28640, 28641, 28656, 28657, 28673, 28685, 28686, 28695, 28725, 28731, 28748, 28760, 28788, 28793, 29575, 29591, 29796, 29798

28368 (AD-A–216476/2/XAB) **Superconductivity of thin-film intermetallic compounds. Research progress and forecast report, 1 September 1984-1 March 1985.** Goldman, A. Minnesota Univ., Minneapolis, MN (USA). School of Physics and Astronomy. 31 Mar 1985. 21p. Available from NTIS, PC A03/MF A01.

The major effort related to facilities has been the upgrading of the multi-source electron beam deposition system which is used to prepare the ternary and pseudoternary compounds that are being studied under the program. The vacuum chamber has been equipped with a Williamson noncontacting temperature sensing system for monitoring substrate temperature. With this system the temperature of the substrate is determined by computing the ratio of radiant energies emitted from the surface in two adjacent wavebands. We have not purchased a rate monitor which uses Electron Impact Emission Spectroscopy (EIES). The currently commercially available instrument, supplied by Inficon, has the capability for controlling only two sources, whereas in our applications there is a need for control of up to four.

28369 (AD-A–216688/2/XAB) **Superconducting thin films, composites, and junctions. Interim report, 1 October 1984-31 March 1985.** Geballe, T.H. Stanford Univ., CA (USA). Dept. of Applied Physics. Aug 1985. 8p. Available from NTIS, PC A02/MF A01.

The important issue of how the superconducting transition temperature T(c) in disordered systems changes near the M-I transition has been studied in the Mo-Ge system. In the high Mo concentration, which is in the weakly localized regime, T(c) decreases linearly with decreasing Mo concentration from 7.5 K (78 at.% Mo) at a rate of approx. 0.18 K/at.% Mo. In this region the ratio of electron-phonon coupling constant gamma to the bare density of states N(b)(O) is constant, which is consistent with the Varma-Dynes tight-binding model. An extrapolation of the linear behavior of T(c) in this regime yields the disappearance of T(c) near 35 at.% Mo. However, measurements show that T(c) exists down to 13.5 at.% Mo. A non-superconducting metallic phase is found to exist between 13.5 at 10.4 at.% Mo at which concentration the insulated phase occurs.

28370 (AD-A–216946/4/XAB) **Metalloboranes as precursors to metallic glasses. Final report, 1 July 1986-30 September 1989.** Fehlner, T.P. Notre Dame Univ., IN (USA). 9 Dec 1989. 13p. Available from NTIS, PC A03/MF A01.

Metal organic chemical vapor deposition (MOCVD) is a well-established, practical technique for forming simple as well as complex solid-state films. Metal-rich metalloboranes constitute practical, low temperature precursors for the vapor deposition of pure, amorphous alloy thin films. This has been demonstrated for the compositions Fe4B and Fe3B. Further, the same approach permits the deposition of refractory borides, e.g., MnB4, under mild conditions. Reaction observed during deposition suggests a route to ternary films of precise composition. The results also suggest that main-group transition-element clusters in general constitute sources of solid-state materials with composition fixed by the precursor.

28371 (CEGB-RD/B–6230/R89) **The release of fission products from uranium metal: a review.** Minshall, P.C. Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs. Mar 1989. 106p. Order Number DE90624388. Available from NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS.

The literature on the release of fission products as gaseous species from irradiated uranium metal in oxidising atmospheres has been reviewed. Release of actinides and of fission products as spalled particulate were not considered. Data is given on the release in air, carbon dioxide, steam and mixtures of steam and air. The majority of data discussed lie between 800 and 1200^{0}C though some results for xenon, krypton and iodine releases below 800^{0}C are given. Two measures of fission product release are discussed: the release fraction, F(tot), which is the ratio of the total release to the initial inventory, and the fractional release, F(ox), which is the fraction released from the oxidised metal. The effect of burn-up, atmosphere and temperature on F(tot) and F(ox) is examined and the conditions under which the release fraction, F(tot) is proportional to the extent of oxidation discussed. (author).

28372 (CEGB-RD/M–1832/RR89) **Hot wire TIG temper bead welding for nuclear repairs.** Lambert, J.A.; Gilston, P.F. Central Electricity Generating Board, Southampton (UK). Marchwood Engineering Labs. Aug 1989. 25p. Order Number DE90624313. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A preliminary assessment has been carried out to determine the suitability of the hot wire tungsten inert gas (TIG) welding process for the repair of thick section, ferritic steel nuclear pressure vessels. The objective has been to identify a hot wire TIG temper bead procedure, suitable for repairs without post weld heat treatment. This procedure involves depositing two weld layers with carefully selected welding parameters such that overlapping thermal cycles produce a refined and tempered heat affected zone, HAZ, microstructure. (author).

28373 (CONF-900395–1, pp. 9-11) **Carbon deposition and deactivation of metallic catalysts.** Terry, R. (Auburn Univ., AL (USA)); Baker, K. USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

Carbon deposition on metal surfaces is one of the most common causes of catalyst deactivation in hydrocarbon conversion and CO/H_2 reactions. The structure of the carbon deposit can range from amorphous to highly crystalline. The current program which will focus on the formation of carbonaceous deposits on nickel, cobalt, platinum, and some of their alloys is designed to address the following scientific issues: (a) the effect of crystallographic orientation and size of the catalyst particle on the structure of the carbon deposit. (b) The effect of modifications to the surface and bulk properties of the catalyst particles on the carbon deposition process. (c) The relationship between the structural characteristics of the carbon deposited on a given catalyst system and that of the hydrocarbon source. (d) An examination of the concept of removing deposited carbon from a deactivated catalyst system at low temperature in an atomic oxygen environment, and thereby minimizing the degree of particle sintering.

28374 (CONF-900395–1, pp. 12) **Electronic structure of clusters and their reactivities.** Balasubramanian, K. (Arizona State Univ., Tempe (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The authors are investigating electronic structure of very heavy metal clusters such as Rh_3, Pt_3, Au_4, Ag_4, Cu_4, Pd_3, etc. Theoretical investigations of such clusters are made using relativistic ab initio multi-configuration self-consistent field (MCSCF) followed by large-scale configuration interaction (CI) calculations which include up to 3 million configurations. The geometries, ionization potentials, energy separations of low-lying excited electronic states, binding energies and other properties of such clusters are studied. The reactivity trends of these clusters are investigated through model potential energy surfaces for systems such as Pd_3 + H, Ni_3 + H, Pt_2 + H_2, Pd_2 + H_2, etc. Results obtained on both bare metal clusters and their reactivities will be discussed.

28375 (CONF-900395–1, pp. 13-16) **Selectivity of the reactions of oxygenates on transition metal surfaces.** Barteau, M.A. (Univ. of Delaware, Newark (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The goal of this research is to understand, by means of surface science studies, the elementary processes involved in the synthesis of methanol and higher oxygenates on transition metals, and the dependence of these processes upon the nature of the surface. Such oxygen-containing molecules may well be the fuels and chemical feedstocks of the future. We have completed a considerable body of work on the reactions of alcohols, aldehydes, and carboxylic acids on clean and oxygen-containing Pd(111) surfaces. More recent attention has been focused on the surface chemistry of rhodium.

28376 (CONF-900395–1, pp. 17-20) **Effects of dispersion and support on adsorption, catalytic and electronic properties of cobalt/alumina CO hydrogenation catalysts.** Bartholomew, C.H. (Brigham Young Univ., Provo, UT (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The origin of observed, dramatic variations in CO hydrogenation activity and selectivity of cobalt with variations in preparation, metal loading, and dispersion-whether a result of changes in surface structure or due to support effects is of fundamental interest. An investigation of the effects of surface structure, dispersion, and support on the adsorption, catalytic, and electronic properties of cobalt/alumina is in progress, the objectives of which are to: (1) determine the effects of surface structure and metal dispersion on the adsorption and catalytic properties of cobalt and (2) determine the effects of support on the adsorption, catalytic and electronic properties of cobalt/alumina.

28377 (CONF-900395–1, pp. 48-51) **Research summary.** DePristo, A.E. (Ames Lab, IA (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The general focus of this research is the theoretical description of the structure and dynamics of chemically reactive systems in terms of their fundamental atomic (and electronic) constituents. Research is designed to describe, calculate, predict and understand the properties of unusual chemical systems. One particular focus is the area of metal cluster chemistry. The goal is to determine the structure and energy of various metal clusters, and to investigate the relationship between these properties and the reactivity of clusters with different gas phase molecules. We have carried out the first detailed theoretical and computational investigation of the structures and reactivity of various isomers of small metal clusters.

28378 (CONF-900395–1, pp. 64-67) **Model heteroatom removal reactions on molybdenum.** Friend, C.M. (Harvard Univ., Cambridge, MA (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. DOE Contract FG02-84ER13289. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The studies of alcohols and cyclic oxides serve as models for catalytic deoxygenation of synthetic fuels while the studies of the S-analogs, thiols and cyclic sulfides, are models for desulfurization catalysis. The effect of surface modification by oxygen and sulfur overlayers has also been investigated in order to better understand the effect of sulfides and oxides on the catalytic process. Experimentally, the comparison of the reactivity for related molecules, such as thiols and alcohols, allows for a general understanding of important factors controlling heteroatom removal reactions. The methods used to investigate these processes are x-ray photoemission, temperature programmed reaction, near edge x-ray absorption fine structure, and Auger electron spectroscopies in conjunction with isotope labelling.

28379 (CONF-900395–1, pp. 80-83) **Correlations between surface structure and catalytic activity/selectivity.** Goodman, D.W. (Texas A and M Univ., College Station (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The project objective is to address those issues which are keys to understanding the relationship between surface structure and catalytic activity/selectivity. This objective also includes the understanding of the origins of the enhanced catalytic properties of mixed-metal catalysts. The experimental approach utilizes a microcatalytic reactor contiguous to a surface analysis system, an arrangement which allows in vacuo transfer of the catalyst from

one chamber to the other. Surface techniques being used include Auger (AES), UV and X-ray photoemission spectroscopy (UPS and XPS), temperature programmed desorption (TPD), low energy electron diffraction (LEED), high resolution electron energy loss spectroscopy (HREELS) and fourier transform infrared spectroscopy (FTIR). Selected examples of recent research activities are summarized.

28380 (CONF-900395–1, pp. 98-101) **Surface analyses and modeling of rate multiplicity and instabilities.** Harold, M.P. (Univ. of Massachusetts, Amherst (USA)); Conner, W.C. USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

This research is an integrated experimental and modeling study of catalytic reactions which exhibit multiple rate phenomena and oscillatory behavior. The occurrence of a multivalued or time-dependent rate implies the existence of nonlinear interactions between the reaction sequence steps and transport processes. Most previous observations of these phenomena were carried out under conditions with external transport limitations and nonisothermalities. Confirmation that such phenomena occur in the absence of transport effects demands the development of kinetic models capable of predicting the multiplicity and oscillation features. Determining the origin(s) of an oscillatory rate requires knowledge of the degree of spatial uniformity along the catalyst surface. The ability to spatially resolve the surface composition during an oscillation and under uniform temperature conditions would help to identify the isothermal communication mechanisms.

28381 (CONF-900395–1, pp. 88-90) **Interaction of molecules with surfaces.** Greene, E.F. (Brown Univ., Providence, RI (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The authors use beams of atoms and molecules striking surfaces to study: the rate of transfer of electrons between a gas and a solid; the transfer of energy between gases and solids; and the rearrangements of the atoms on surfaces of crystals that occur when the temperature changes, when atoms are adsorbed, or when forces parallel to the surfaces change, e.g. as a result of bending the crystal.

28382 (CONF-900395–1, pp. 102-104) **Optical studies of molecular adsorbates.** Hemminger, J.C. (Univ. of California, Irvine (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

This research program utilizes optical probes to study the chemistry of molecular adsorbates in monolayers and few layer thick thin films on single crystal metal substrates. While many advances have been made in the development of methods to study surfaces and surface phenomena, the determination of the molecular composition of a complex monolayer reaction mixture, or a few layer thick film on a low surface area material is still extremely difficult. It is with the development of such molecular probes of surfaces in mind that we are carrying out optical studies of molecular adsorbates. The chemistry which is of particular interest to our DOE program at present is the chemistry of strong organic oxidizing agents such as tetracyanoquinodimethane and thiophene which can be polymerized in ultra-thin films.

28383 (CONF-900395–1, pp. 112-113) **Molecular structure and chemical reactivity on surfaces.** Hrbek, J. (Brookhaven National Lab., Upton, NY (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The main objective of this research program is to improve the understanding of molecular processes at the gas-solid interface. The characterization of adsorbate bonding, identification of surface intermediates and their molecular structure, and the effects of surface modifiers on the bond activation and dissociation is of fundamental importance to surface chemistry. The ultimate goal of these research activities is to control molecular interactions at surfaces with the aim of altering the activity, selectivity and poison resistance of catalysts.

28384 (CONF-900395–1, pp. 114-117) **Heterogeneous catalysis related to energy systems.** Huntley, D.R. (Oak Ridge National Lab., TN (USA)); Krause, M.O.; Mullins, D.R.; Overbury, S.H. USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The general objective of this project is to study fundamentals of surface reactivity by examining atomic and molecular interactions at well characterized surfaces. The emphasis is on elucidation of mechanistic details of reactions, especially hydrodesulfurization, at metal and modified metal surfaces. The adsorption, decomposition, reaction and desorption of organosulfur compounds are studied on single crystal surfaces by a variety of surface analytical techniques, including various electron spectroscopies, isotope incorporation, and temperature programmed reactions. Structure is probed through the use of low energy alkali ion scattering to analyze atomic structure of clean surfaces, the effects of adsorbates on substrate structure and the bonding sites of adatoms. A long term goal is understanding the relation between structure and reactivity.

28385 (CONF-900395–1, pp. 133-134) **Chemistry of bimetallic and alloy surfaces.** Koel, B.E. (Univ. of Southern California, Los Angeles (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

Careful design of experiments can isolate the several factors that control surface chemistry and catalysis on biometallic and alloy surfaces. We use well-characterized surfaces formed by vapor deposition of metal adatoms on single crystal metal substrates. The span of systems investigated allows us to carry out for the first time a separation of geometric and electronic effects on bimetallic platinum surface chemistry. For example, K and Sn adatoms on Pt clearly have both important electronic and geometric effects, and these effects are distinguished. Importantly, this work considers at the atomic scale the influence of bimetallic surfaces on hydrocarbon reactions. We report here on results of chemisorption studies of H_2, CO, C_2H_4, and C_2H_2 on these model bimetallic catalysts.

28386 (CONF-900466–5) **Grain boundary intermetallic phases in alloy 718.** Burke, M.G. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Science and Technology Center); Miller, M.K. Oak Ridge National Lab., TN (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90009812. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A nickel base superalloy which is widely used in power generation applications, Alloy 718, has been studied by analytical electron microscopy in order to elucidate the development of the complex

microstructure which is produced during a typical multistage thermal treatment. The distribution of δ, γ'', γ' and Laves phases was found to be strongly dependent on aging treatment. 7 refs., 5 figs.

28387 (CONF-900466–6) **Atom probe analysis of the compositions of γ' and γ'' intermetallic phases in nickel-based superalloy 718.** Miller, M.K. (Oak Ridge National Lab., TN (USA)); Burke, M.G. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90009858. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An atom probe field ion microscopy and transmission electron microscopy characterization has been performed on the intragranular precipitates that are formed in a niobium-modified nickel-base superalloy 718 after the various stages of a multistage heat treatment. Atom probe results indicate that there is a wide variation in the compositions of the DO_{22}-ordered γ'', the Ll_2-ordered γ' precipitates and the γ matrix with heat treatment and with position in the microstructure. 7 refs., 4 figs., 7 tabs.

28388 (CONF-900466–10) **Improved methods and novel techniques for jet electropolishing of TEM [transmission electron microscope] foils.** Kestel, B.J. Argonne National Lab., IL (USA). Mar 1990. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90010112. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Experience has shown that the difficulties encountered in jet polishing of TEM foils can be minimized by the selection of equipment and an electrolyte appropriate for each material. The use of a jet polishing instrument for more than one type of specimen preparation after minor modification will be presented. Some insights on the relationship and manipulation of the parameters involved in achieving well polished TEM foils having appropriate surface quality, thin area, and perforation size will be included. Methods used to develop new electrolytes for specific purposes and the results of their use on both conventional and superconducting materials will be shown. A technique to calibrate equipment for more reproducible specimen hole size, use of new electrolytes and various materials, the salvage of unsatisfactory foils, and thinning of undersized specimens will be reviewed. 13 refs., 30 figs.

28389 (CONF-900617–7) **The effect of aging at 343°C on type 308 stainless steel weldments.** Alexander, D.J.; Alexander, K.B.; Miller, M.K.; Nanstad, R.K. Oak Ridge National Lab., TN (USA). [1990]. 7p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. From Pressure vessels and piping conference: be in tune for the 90's; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE90009232. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The effect of long-term aging at intermediate temperatures on the mechanical properties of stainless steel welds has been studied. Three type 308 multipass shielded metal-arc welds with ferrite levels of 4, 8, and 12% were aged up to 343°C. Tensile tests showed little effect of aging on either the yield or ultimate tensile strengths, but the impact toughness was significantly degraded. The extent of the degradation increased with increasing ferrite content and increasing aging time. Examination of the microstructure with transmission electron microcscopy and atom probe field-ion microscopy revealed that the ferrite phase had undergone spinodal decomposition as a result of aging. In addition, G-phase particles were observed at dislocations, and finer G-phase particles were homogeneously distributed throughout the ferrite phase. The changes in the mechanical properties and the fractography are discussed in light of the observed changes in the microstructure. 19 refs., 7 figs., 2 tabs.

28390 (CONF-9006149–1) **Welding behavior and welding metallurgy of ductile intermetallic alloys.** David, S.A.; Santella, M.L. Oak Ridge National Lab., TN (USA). [1990]. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 1. United States - Japan symposium on advances in welding metallurgy; San Francisco, CA (USA); 7-8 Jun 1990. Order Number DE90008908. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Welding behavior and welding metallurgy of several ordered intermetallic alloys are reviewed comprehensively. Weldability of these alloys has been found to be a strong function of composition, welding process and process parameters. Phase transformations associated with the weld thermal cycle play a critical role in determining the weldability of these alloys. Defect-free welds have been produced in several of these alloys. 31 refs., 11 figs., 3 tabs.

28391 (CONF-9006162–1) **Characterization of weldments using advanced experimental techniques.** Vitek, J.M.; David, S.A. Oak Ridge National Lab., TN (USA). [1990]. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 1. U.S.-Japan symposium on advances in welding metallurgy; Yokohama (Japan); 12-13 Jun 1990. Order Number DE90009418. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Many advanced experimental techniques that allow for more detailed characterization of materials have been developed over the last decade or two. These experimental techniques are divided into three categories: microstructural characterization, mechanical properties measurement, and simulation. Many of these techniques are ideally suited for the examination of weldments, including the fusion zone and the heat-affected zone. The advanced experimental methods allow for better evaluation of weldment microstructures and properties, given that microstructural and compositional gradients and present in weldments. Several of these techniques are reviewed and examples of the type of information that can be obtained are given. The application of these techniques can provide new information on weldment phase transformations, phase stability, and weldment properties which should provide a basis for improved welds. 64 refs., 11 figs.

28392 (DOE/ER/12093–1) **Oxidation of cobalt-chromium alloys in chlorine contaminated environments.** Kim, S.H. (Illinois Univ., Chicago, IL (USA). Dept. of Civil Engineering, Mechanics, and Metallurgy); McNallan, M.J.; Liang, W.W. Illinois Univ., Chicago, IL (USA). Dept. of Civil Engineering, Mechanics, and Metallurgy. [1983]. 2p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-82ER12093. Order Number DE83010800. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In concentrations up to 30%, Cr does not form a dense protective scale on Co-Cr alloys in such environments. The linear rate constants for all the Co-Cr alloys (1 to 30% Cr) were 5 to 7 x 10^{-7} g/cm^2-s, about one third the rate constant for pure Co. The scale contained very little chlorine, consisting of Co oxides and possibly $CoCr_2O_4$. (DLC)

28393 (DOE/ER/13607–2) **[Effective elastic properties of cracked solids]: Progress report.** Kachanov, M. Tufts Univ., Medford, MA (USA). Dept. of Mechanical Engineering. [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13607. Order Number DE90009836. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This progress report briefly describes work on effective properties of cracked solids, publications and next year's (starting 9/01/90) funding. 2 refs. (JDL)

28394 (DOE/ER/45338–T2) **Modeling and experimental studies of oxide covered metal surfaces: Progress report.** Smyrl, W.H. (Minnesota Univ., Minneapolis, MN (USA). Corrosion Research Center); Halley, J.W.; Oriani, R.A.; White, H.S.; Toney, M.F.; Melroy, O.R. Minnesota Univ., Minneapolis, MN (USA). Corrosion Research Center. [1990]. 34p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER45338. Order Number DE90009961. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The collaborative research effort of the Aqueous Group of the Corrosion Research Center has focussed on the physical, chemical, and electronic structure of native and anodically grown TiO_2 films. The stability of Ti in corrosive environments is due entirely to the presence of the oxide film; thus, our goal is to correlate measurable structural parameters of the oxide film with the corrosion resistance that it imparts to the base metal. The fundamental nature of both theoretical and experimental approaches taken in studying

TiO_2 films will allow key factors underlying oxide film stability to be identified and translated to other materials. 44 refs., 1 tab., 7 figs.

28395 (EGG-MS–8865) **Microstructure and mechanical properties of nickel aluminide powders consolidated by extrusion and hot isostatic pressing.** Wright, R.N.; Knibloe, J.R.; Williamson, R.L. EG and G Idaho, Inc., Idaho Falls, ID (USA). Jan 1990. 44p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC07-76ID01570. Order Number DE90009777. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The influence of alloying additions of iron and chromium, alone and in combination with molybdenum and zirconium, on the heat treatment response and mechanical properties of powder metallurgy Ni_3Al based materials consolidated by hot extrusion has been characterized in detail. Consolidation of the nickel aluminide powders by hot isostatic pressing (HIP) has been examined as an alternative to extrusion. Densification has been simulated using a model that describes consolidation by the additive effects of plastic flow, power-law creep, boundary diffusion, and Nabarro-Herring and Coble creep. The model has been used to develop maps that describe densification for any combination of time, temperature, and pressure. The best available material property data and parameters from experiments have been used to develop maps that describe HIP consolidation experiments with reasonable accuracy. Finite element models were developed as an extension of the HIP map approach to provide detailed simulations of particle deformation during densification. Preliminary results for both monosized and bimodal particle distributions indicate that this particle level approach is useful for simulating microstructural development resulting from different combinations of consolidation parameters. 45 refs., 22 figs., 22 figs., 4 tabs.

28396 (EUR–12285) **Evaluation of the onset of tertiary creep for types 304 and 316 stainless steels.** Staerk, E. (International Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)); Picker, C.; Felsen, M.F. Commission of the European Communities, Luxembourg (Luxembourg). 1989. 44p. Contract RA1-0104-D. Available from NTIS (US Sales Only), PC A03/MF A01.

Austenitic stainless steels Types 304 and 316 are used for LMFBR components. Although at high temperature many codes base the allowable stress on the stress rupture strength, some recent codes eg ASME Code Case N47 and RCC-MR also take account of the onset of tertiary creep. In order to examine this latter aspect creep deformation data on Type 304 and Type 316 steel have been collected and analysed. The ratio time to onset of tertiary creep against the time to rupture has been analysed as a function of temperature. At temperatures below 750^0 C the ratio is found to decrease slightly with increasing temperature. Monkman Grant and Lambda relationships have also been investigated. In relation to the ASME S_t allowable stress criteria it is shown that below 600^0 C the allowable stress is likely to be governed by the stress rupture strength rather than the onset of tertiary creep criterion. Recommendations are given concerning the determination of the onset of tertiary creep, the fitting of the Leyda/Rowe relationship and a method to compute the maximum allowable stress S_t from equation describing the time-temperature dependency of the three constituents of S_t.

28397 (EUR–12329) **Joint research centre fusion materials irradiations in HFR: present status and prospectives.** Casini, G. (Commission of the European Communities, Ispra (IT). Joint Research Centre); Penici, P. Commission of the European Communities, Luxembourg (Luxembourg). 1989. 23p. Available from NTIS (US Sales Only), PC A03/MF A01.

First a review is made of the Joint Research Centre experimental activity at HFR-Petten in the frame of the Fusion Technology and Safety Programme. The materials under investigation are: . Cr-Ni Austenitic steels (316-L type) and Cr-Mn Austenitic Steels (AMCR and FI type) as structural materials and . Pb-17Li eutectic as tritium breeding material. The experiments on structural materials comprise: . Sample irradiations with post-irradiation tensile tests (FRUST) . Sample irradiations under constant load and post-irradiation strain measurement (TRIESTE) . On-line creep tests (CRISP). The experiments on Pb-17Li breeder material regard sample irradiations to investigate tritium production and recovery as well as tritium permeation through blanket structures (LIBRETTO Experiment). Both irradiations on structural and breeding materials will be pursued. Expected developments of the testing programme at HFR are discussed. New areas of research should involve materials for divertor applications (NET/ITER) and advanced low activation composite materials for Commercial Power Reactors.

28398 (JAERI-M–89-210) **Creep curve formularization by constant stress creep tests.** Kaji, Yoshiyuki (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Muto, Yasushi. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 51p. (In Japanese). Order Number DE90777754. Available from NTIS (US Sales Only), PC A04/MF A01.

Creep tests under constant stress were conducted on a nickel-base heat-resistant alloy, Hastelloy XR-II, which is one of the condidate alloys for applications in the process-heat high-temperature gas-cooled reactor (HTGR). In those tests relation between minimum creep strain rate, time to onset of tertiary creep, time to rupture and stress were investigated. Then, creep constitutive equation was made based on the Garofalo formula for the primary and secondary creep and the Kachanov-Rabotnov formula for the tertiary creep using these parameters. As results of the comparison between a calculated creep curve using these creep constitutive equation and an experimental creep curve, it was found that these equation could predict fairly well the creep strain behavior under the constant stress condition. Numberical analyses of relaxation behavior under tension strain hold waves in high-temperature low-cycle fatigue tests were performed using creep constitutive equation and strain hardening law. As results of comparison with numerical analyses and experimental results, it was found that the values of calculated stress were somewhat higher than those of the test results. In addition, relaxation tests were conducted on Hastelloy XR-II at 850degC under ϵ_t = 0.15 % condition and comparison between experimental results and calculated results which were performed using two types of creep constitutive equations were carried out. As these results, it was found that the values of calculated stress were somewhat higher than those of the experimental results. Therefore, it is still necessary to investigate the accuracy of creep constitutive equation. (author).

28399 (KEK–89-2, pp. 159-171) **Measurement of degassing from material for ultra-high vacuum equipment.** Saito, Shoji (Tokyo Electron Ltd., Tokyo (Japan)); Momose, Takashi; Ishimaru, Hajime. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

Measurements are made to determine the rate of degassing from 18 materials developed for ultra-high vacuum equipment in order to evaluate their relative performance. Surface structures are observed and their relations with the degassing rate are investigated. The pumping system and the whole sample chamber are placed in a constant-temperature bath, and the degassing rate for each sample is measured by the through-put method. The surface is observed by scanning electron microscopy, and its roughness is analyzed quantitatively. AES analysis is also made to determine the distribution of elements in the depth direction. The degassing rate is measured after 10 hours of initial pumping at room temperature, and 24 and 100 hours after the end of baking. For most of the materials consisting mainly of aluminum, a degassing rate near 10^{-13} torr·l/s·cm^2 can be achieved without fail. For some materials, a degassing rate of the order of 10^{-14} is achieved after adequate heating/degassing. The surface observations show that the surface of thes ematerials have structures of 0.1-100μm. (N.K.).

28400 (KEK–89-2, pp. 183-188) **Surface observation and degassing rate measurement for SUS304 plate (belt-polished, buffed, electropolished).** Yoshimura, Nagamitsu (Japan Electron Optics Lab. Co. Ltd., Akishima, Tokyo (Japan)); Hirano, Haruo; Kanazawa, Toshiyuki. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for

accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

SUS304 plates (2mm thick) manufactured by Nippon Steel Corporation are belt-polished, buffed or electropolished to provide samples. Their surface is observed by scanning electron microscopy, and their degassing rates are measured. The surface of non-polished steel contains crystal grains of about 10μm diameter, and is covered with relatively thick oxide layer. The belt-polished surface contains rough polishing marks, with relatively large and deep flaws remaining unremoved. The buffed surface also contains flaws though smoother than the belt-polished surface. The buffed sample is lower in degassing rate than the belt-polished sampel before baking. This can be attributed to the difference in the size and depth of flaws. Electropolishing can produce very smooth surface almost free from flaws or pinholes. The electropolished SUS304 plate sample is much lower in degassing rate than the belt-polished and buffed samples both before and after baking. Its degassing rate is particularly small after baking. This attributed to the fact that the thick, porous oxide surface layer is removed by electropolishing. (N.K.).

28401 (KEK–89-2, pp. 189-194) **Measurement of total and partial pressure in ultra-high vaccum aluminum alloy chamber.** Watanabe, Fumio (Sakura-no-Seibo Gakuin Senior Highschool, Fukushima (Japan)); Sugisaki, Kenzaburo; Ishimaru, Hajime. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

A large aluminum alloy chamber equipped with 21 gauge ports was produced in High-Energy Physics Research Institute. It is designed to calibrate many ultra-high vacuum gauges at a time. When an extractor gauge is used to measure the pressure in the chamber, it gives a reading of $1X10^{-10}$ Pa, which is the measuring limit. This suggests that the actual pressure may be lower than this. Then, a point ion collector gauge is employed for more accurate pressure measurement. An analysis of the residual gas in the chamber is carried out by using a newly developed quadrupole analyzer. The chamber is cylindrical, 250 mm in diameter and about 1800 mm in length. LN_2 shrouds are provided in the chamber to eliminate interaction between the gauges. The chamber is backed for about two days and pumped by an ion pump to obtain a high vacuum of nearly 10^{-9} Pa, followed by pumping by a titanium sublimation pump. This achieves an ultra-high vacuum of nearly 10^{-11} Pa, which is measured with a point collector gauge. The new quadrupole analyzer is found to be able to analyze residual gas under a pressure of nearly 10^{-11} Pa. (N.K.).

28402 (N–90-15211) **Secondary electron emission characteristics of molybdenum-masked, ion-textured OFHC copper.** Curren, A.N.; Jensen, K.A.; Roman, R.F. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Jan 1990. 15p. (NASA-TP–2967;E–5009;NAS–1.60:2967). Available from NTIS, PC A03/MF A01.

A method for producing a uniform, highly textured surface on oxygen-free, high conductivity (OFHC) copper by ion bombardment using sputtered molybdenum as a texture-inducing masking film was developed and used to provide samples for study. The purpose was to develop a basically OFHC copper surface having very low secondary electron emission characteristics. Surfaces having low secondary electron emission are a requirement for the electrodes of very high efficiency multistage depressed collectors (MDC's). Such MDC's are used in microwave amplifier traveling wave tubes for space communications and other applications. OFHC copper is the material most commonly used for MDC electrodes because it has high thermal conductivity, it is easy to machine, and its fabrication and brazing procedures are well established. However, its untreated surface displays relatively very high levels of secondary electron emissions. Textured OFHC copper samples were tested for true secondary electron emission and relative reflected primary electron yield at primary electron beam energy levels from 200 to 2000 eV and at direct (0 deg) to oblique (60 deg) beam impingement angles. The test results for three of the samples, each of which was processed in a slightly different way, are compared with each other and with test results for a machined OFHC copper sample. Although the textured samples are not represented here as having been processed optimally, their measured secondary electron emission characteristics are significantly lower than those of the untreated OFHC copper sample over the range of conditions studied. Importantly, the relative reflected primary electron yield of one of the textured samples is conspicuously lower than that of the others. Clearly, with further development, the molybdenum-masked ion-textured OFHC copper surface will be a promising material for high-efficiency MDC electrodes.

28403 (N–90-16053) **Production and processing of Cu-Cr-Nb alloys.** Ellis, D.L.; Michal, G.M.; Orth, N.W. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Jan 1990. 14p. (NASA-TM–102495;E–5286;NAS–1.15:102495). Available from NTIS, PC A03/MF A01.

A new Cu-based alloy possessing high strength, high conductivity, and good stability at elevated temperatures was recently produced. This paper details the melting of the master alloys, production of rapidly solidified ribbon, and processing of the ribbon to sheet by hot pressing and hot rolling.

28404 (N–90-16686, pp. 292-302) **The effects of hydrogen embrittlement of titanium.** Taylor, D.J. University of Central Florida, Orlando, FL (USA). Oct 1989. (NASA-CR–166837;NAS–1.26:166837;CONF-8906315–: NASA/ASEE summer faculty fellowship program conference, Merritt Island, FL (USA), 5 Jun 1989). In *NASA/ASEE Summer Faculty Fellowship Program.* Available from NTIS, PC A18/MF A03.

Titanium alloys, by virtue of their attractive strength to density ratio, fatigue, fracture toughness and corrosion resistance are now commonly used in various aerospace and marine applications. The cost, once very expensive, has been reduced, making titanium even more of a competitive material today. Titanium and titanium alloys have a great affinity to several elements. Hydrogen, even in small amounts, can cause embrittlement, which in turn causes a reduction in strength and ductility. The reduction of strength and ductility is the subject of this investigation.

28405 (NAGRA-NTB–88-02E) **The corrosion behaviour of carbon steel in Portland cement.** Grauer, R. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Jan 1988. 27p. Available from Nagra, CH-5401 Baden, Switzerland.

The production of hydrogen can cause problems in a repository for low- and intermediate-level waste. Since gas production is mainly due to the corrosion of carbon steel, it is important to have as reliable data as possible on the corrosion rate of steel in anaerobic cement. A review of the literature shows that the corrosion current densities lie in the range 0.01 to 0.1 $\mu A/cm^2$ (corresponding to corrosion rates between 0.1 and 1.2 μm/a). This implies hydrogen production rates between 0.022 and 0.22 $mol/(m^2.a)$. Corrosion rates of this order of magnitude are technically irrelevant, with the result that there is very little interest in determining them accurately. Furthermore, their determination entails problems of measurement technique. Given the current situation, it would appear somewhat risky to accept the lower value for hydrogen production as proven. Proposals are made for experiments which would reduce this element of uncertainty. (author) 10 figs., 35 refs.

28406 (ORNL/FMP–89/2, pp. 253-262) **INEL-2(A) - Consolidation of rapidly solidified aluminide metal powders.** Wright, R.N. (Idaho National Engineering Lab., Idaho Falls (USA)). Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

This project will determine the most effective method of processing alloys based on the intermetallic compounds Ni_3Al and Fe_3Al to obtain optimum mechanical properties studies for Ni_3Al involves

application of powder metallurgy methods to these alloys. Powder metallurgy (P/M) processing of aluminide powders can result in fine grain size, improved chemical homogeneity, a non-equilibrium degree of order, and near-net shape consolidation. Consolidation of Ni_3Al by hot extrusion and hot isostatic pressing (HIPping) are being investigated. Extrusion consolidation has been performed by outside vendors and has not included parametric studies of the influence of consolidation parameters on densification. For HIPping studies, effective use of the variables time, temperature, and pressure has been investigated. The primary emphasis will be to determine the effects of the consolidation processes on resulting properties.

28407 (ORNL/FMP–89/2, pp. 477-484) **ORNL-3(A) - Development of surface treatments and alloy modifications for corrosion-resistant oxide scales.** DeVan, J.H. Oak Ridge National Lab., TN (USA). Jan 1990. In *Fossil Energy Advanced Research and Technology Development Materials Program. Semiannual progress report for the period ending September 30, 1989.* Order Number DE90008393. Available from NTIS, PC A25/MF A01.

The purpose of this task is to develop protective scales on iron-based alloys in mixed-oxidant (oxygen-sulfur) environments for coal-related applications at 500-800°C. Important objectives modifying transport sulfur-diffusional to minimize the sulfur attack; and (3) study of the effects of alloy chemistry, oxide morphology, and temperature on the breakdown of protective scales. Oxidation and sulfidation studies of Fe_3Al based alloys have continued. Developmental alloys containing additions such as Cr, Nb, Mo, Zr, Y, and B are being exposed to H_2S-H_2H_2O gas mixtures at 700 and 800°C, respectively.

28408 (PB–90-860214/XAB) **Tungsten and tungsten alloy powder metallurgy. January 1970-February 1990 (A Bibliography from the NTIS data base). Report for January 1970-February 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 156p. Available from NTISPC N01/MF N01.

Supersedes PB–87-863536.

This bibliography contains citations concerning the processing and fabrication of tungsten, tungsten alloys, and tungsten composites. Compacting, pressing, sintering, extruding, and rolling are among the methods described. Infiltration of porous tungsten shapes is included, as well as mechanical properties, thermal properties, and microstructure of these products. Applications include rocket nozzles, nuclear reactor materials, and porous ionizers. (This updated bibliography contains 287 citations, 53 of which are new entries to the previous edition.)

28409 (PB–90-860354/XAB) **Stress corrosion of stainless steel. January 1976-June 1987 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1976-June 1987.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 123p. Available from NTISPC N01/MF N01.

See also PB–90-860362.

This bibliography contains citations concerning the stress-corrosion behavior of austenitic and stainless steels. Fatigue and cracking characterization, corrosion-mechanism studies, and test methods used to study crack initiation and fracture are discussed. The effects of high-salt-concentration solutions and high-temperature environments on stress corrosion are also considered. Corrosion problems in nuclear power plants are presented. (This updated bibliography contains 251 citations, none of which are new entries to the previous edition.)

28410 (PB–90-860362/XAB) **Stress corrosion of stainless steel. July 1987-January 1990 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for July 1987-January 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 87p. Available from NTISPC N01/MF N01.

Supersedes PB–87-862264. See also PB–90-860354.

This bibliography contains citations concerning the stress-corrosion behavior of austenitic and stainless steels. Fatigue and cracking characterization, corrosion-mechanism studies, and test methods used to study crack initiation and fracture are discussed. The effects of high-salt-concentration solutions and high-temperature environments on stress corrosion are also considered. Corrosion problems in nuclear power plants are presented. (This updated bibliography contains 138 citations, all of which are new entries to the previous edition.)

28411 (PPLK-R–43) **The decomposition of PdSi by adding small amount of Ag.** Tsumori, K.; Akimune, H. Kyoto Univ., Uji (Japan). Plasma Physics Lab. Jul 1989. 39p. Order Number DE90777724. Available from NTIS (US Sales Only), PC A03/MF A01.

The decomposition of the intermetallic compound PdSi by adding small amount Ag have been investigated by thermal analysis, metallographic measurement and X ray photoemission spectroscopy (XPS). Within the range of Ag concentration below 6 at.%, PdSi is linearly decomposed into Si and the ternary compound Pd_2Si including Ag with the ratio of 16 PdSi molecules per a single Ag atom, and PdSi is fully decomposed at Ag 10 at.%. In the ternary alloy involving Ag below 12 at.%, the atomic ratio of Si to metal atoms, Pd plus Ag in the ternary compound is almost same as that of Pd=rich Pd_2Si. Metallographic and XPS measurements indicate that Ag atom included in the PdSi behaves as an electron donor with large radius of the wave function; the electron flows into the anti= bonding state of PdSi, and acts to decompose the compound, and the Ag atoms seem to occupy the sites of Pd atoms. (author).

28412 (SVF–356) **Experience of austenitic materials in fossil-fuel boilers.** Tavast, J. (ABB Stal AB, Finspaang (SE)). Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden). Oct 1989. 100p. (In Swedish). Order Number DE90770846. Available from NTIS (US Sales Only), PC A05/MF A01.

The study has mainly been aimed at the problems on the steam/water side in order to evaluate if the use of austenitic materials will pose special restrictions on the steam/water chemistry. Experiences of other types of problems have however also been included. Austenitic materials are presently in use in a large number of fossil fired units. The experiences of the austenitic materials are in general satisfactory. The problems which have been observed in austenitic SH/RH-tubes are usually the same as in ferritic SH/RH-tubes, i.e. creep, high temperature corrosion and scaling. The austenitic materials are more prone to stress corrosion cracking than the ferritic materials. The number of failures have however been fairly limited. The failures have usually been caused by mishappenings during operations like regeneration of ion exchangers, acid cleaning etc. Stress corrosion cracking of austenitic SH/RH-tubing is therefore not a justification for tightening of steam/water specifications during normal operation. Thick-walled austenitic components have caused some problems in high temperature units, mainly due to hot cracking of welds in Nb-stabilized materials and due to thermal fatigue. A lot of work is devoted to reducing the problems due to high temperature corrosion and scaling. Factors like grain size, cold work, Cr-content and Cr-rich coatings are all of importance, as is the lay-out of the boiler itself. It has also been possible to reduce the problems with the thick-walled components. In spite of this a considerable amount of work still remains before it will be possible to construct a unit in the 1000 MW range for a steam temperature of 650 deg C. (34 figs., 5 tabs., 76 refs.).

28413 (UCRL–99432) **Precision laser cutting.** Kautz, D.D.; Anglin, C.D.; Ramos, T.J. Lawrence Livermore National Lab., CA (USA). 19 Jan 1990. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-891164–1: 3. biannual conference on the laser vs the electron beam in welding, cutting and surface treatment, Reno, NV (USA), 1-5 Nov 1989). Order Number DE90009949. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Many materials that are otherwise difficult to fabricate can be cut precisely with lasers. This presentation discusses the advantages and limitations of laser cutting for refractory metals, ceramics, and composites. Cutting in these materials was performed with a 400-W, pulsed Nd:YAG laser. Important cutting parameters such as beam power, pulse waveforms, cutting gases, travel speed, and laser coupling are outlined. The effects of process parameters on cut quality are evaluated. Three variables are used to determine the cut quality: kerf width, slag adherence, and metallurgical characteristics of recast layers and heat-affected zones around the

cuts. Results indicate that ductile materials with good coupling characteristics (such as stainless steel alloys and tantalum) cut well. Materials lacking one or both of these properties (such as tungsten and ceramics) are difficult to cut without proper part design, stress relief, or coupling aids. 3 refs., 2 figs., 1 tab.

28414 (UCRL-CR-103260) **Martensitic transformation induced by stress pulses: Final report.** Meyers, M.A. (California Univ., San Diego, La Jolla, CA (USA). Dept. of Applied Mechanics and Engineering Sciences); Ravichandran, G. Lawrence Livermore National Lab., CA (USA); California Univ., San Diego, La Jolla, CA (USA). Dept. of Applied Mechanics and Engineering Sciences. Mar 1990. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90009534. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The objectives of this research program were to establish the preferential sites for martensite nucleation in ferrous alloys. A Fe-30 wt % Ni alloy was used in this investigation. The tensile pulse technique was used to produce a short-duration tensile pulse that triggers the formation of martensite above M_s. The tensile pulse is produced by impact in a gas gun. 2 figs.

28415 **Beyond the embedded atom interatomic potential.** Savino, E.J. (Dept.. of Materials Engineering, Virginia Polytechnic Institute and State Univ., Blacksburg, VA (US)); Rao, S.; Pasianot, R. pp. 471 of Atomic scale calculations in materials science. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1989). Grant N0004-83-K-0750, P00004. (CONF-8811147–: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

The authors discuss some of the advantages and limitations of using embedded atom interatomic potentials for simulating the static configuration and dynamics of lattice defects. In metals, the embedded atom potentials provide a physically more realistic approximation than simple pair interaction potentials without a significant increase in computer time needed for defect simulation studies. However, in some cases, n-body shear forces, i.e. bond angle interatomic forces may be needed for fitting experimental results related to defect configuration. One such example is the elastic neutron scattering data from N interstitials in Nb [1]. Also, such bond angle forces must be included in a realistic model of atomic interactions in metals, especially in highly anisotropic bcc transition metals. Extending the concept of the embedded atom method, the authors propose a new form for the interatomic potential in metals which includes bond angle forces. General expressions for the elastic constants in bcc and fcc structures are deduced. needed for defect simulation studies. However, in some cases, n-body shear forces, i.e. bond angle interatomic forces may be needed for fitting experimental results related to defect configuration. One such example is the elastic neutron scattering data from N interstitials in Nb [1]. Also, such bond angle forces must be included in a realistic model of atomic interactions in metals, expecially in highly anisotropic bcc transition metals. Extending the concept of the embedded atom method, the authors propose a new form for the interatomic potential in metals which includes bond angle forces. General expressions for the elastic constants in bcc and fcc structures are deduced.

28416 **The embedded atom method: Theory and application.** Baskes, M.I (Sandia National Lab.., Livermore, CA (US)); Daw, M.S; Foiles, S.M. pp. 471 of Atomic scale calculations in materials science. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811147–: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

The embedded atom method (EAM), a modern theory of metallic bonding, has been developed to provide a simple but accurate method of evaluating the energy and forces for an arbitrary arrangement of atoms. The relationships between the EAM and the underlying electron density theory are discussed. Specific examples of EAM calculations of surface reconstruction for (110) fcc materials are predicted and compared to experiment. The examples include temperature effects in gold. The results of molecular dynamics calculations of the mechanical properties of nickel also are presented. Topics discussed include dislocation mobility and dislocation emission from a stressed crack in nickel. The dislocation calculations are related to continuum modelling.

28417 **The effect of argon on the metal vapor arc during vacuum arc remelting of Inconel 718.** Zanner, F.J. (Sandia National Labs., Albuquerque, NM (USA)); Williamson, R.L.; Bertram, L.A.; Harrison, R. pp. 60 of Proceedings of the 1987 Pacific Northwest metals and minerals conference (abstracts): Modern mineral and metal technology. Albany Research Center, Albany, OR (USA) (1987). (CONF-8704166–: Pacific Northwest metals and minerals conference, Portland, OR (USA), 26-28 Apr 1987).

Argon gas was introduced into the furnace chamber during vacuum arc remelting (VAR) of 152 ⁻ mm ⁻ diameter Inconel 718 electrodes. The arc behavior was observed by high-speed cinematography and spectroscopy of the smaller melts and global variables such as melt rate and drop-short frequency were observed in the large melts. The results of these experiments are presented.

28418 **Vacuum arc remelting: An overview.** Zanner, F.J. (Sandia National Labs., Albuquerque, NM (USA)); Bertram, L.B.; Williamson, R.L. pp. 60 of Proceedings of the 1987 Pacific Northwest metals and minerals conference (abstracts): Modern mineral and metal technology. Albany Research Center, Albany, OR (USA) (1987). (CONF-8704166–: Pacific Northwest metals and minerals conference, Portland, OR (USA), 26-28 Apr 1987).

The authors discuss the ongoing research program aimed toward understanding the vacuum arc remelting (VAR) process. This paper summarizes these efforts and results with particular emphasis on arc behavior, electrode phenomenon, electrode gap control, and resulting structures. The data for these topics were obtained with both small laboratory-scale experiments and large industrial experiments.

28419 **Unlubricated sliding properties of ion beam and excimer laser mixed Fe-Ti-C multilayered films.** Hirvonen, J.P. (Materials Science and Technology Div., Los Alamos National Lab., Los Alamos, NM (US)); Nastasi, M.; Jervis, T.R.; Tesmer, J.R.; Zocco, T.G. pp. 524 of New materials approaches to tribology: Theory and applications. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

The authors report the results of multilayered Fe-Ti-C films consisting of eleven sublayers vacuum deposited onto an AISI 304 stainless steel substrate and subsequently mixed either 400 keV Xe ions or an excimer laser operating at a wavelength of 308 nm. Ion mixing was accomplished in a two step process: the multilayers were first irradiated with 1×10^{17} Xe/cm$_2$ at 520 °C, after which half of the sample was irradiated with 5×10^{15} Xe/cm$_2$ at O °C. Laser mixing was carried out at both 1.1 and 10. Pin-on-disc studies revealed only slight differences between the two kinds of ion beam mixed samples, whereas the dry sliding properties of laser mixed samples were strongly dependent on the total fluence used. In the optimum conditions, similar friction coefficients were obtained on both kinds of samples.

28420 **Microstructural studies of IAD and PVD Cr coatings by cross section transmission electron microscopy.** Cheng, C.C. (Materials and Components Technology Div., Argonne National Lab., Argonne, IL (US)); Erck, R.A.; Fenske, G.R. pp. 524 of New materials approaches to tribology: Theory and applications. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

The authors report cross section transmission electron microscopy used to study the microstructure and interface structure of Cr films deposited by ion-assisted deposition as a function of the incident ion energy. High-energy ion bombardment (1 keV) was found to enhance the adhesion of the deposited film owing to the formation of an intermixed layer, whereas deposition with low-energy ions (100 eV) was found to reduce or eliminate grain boundary porosity. A tailored Cr film with excellent adhesion and no grain boundary porosity was deposited by combining high-and low-energy ion bombardment.

28421 Tribology of amorphous alloys formed with ion beams. Follstaedt, D.M. (Sandia National Lab., Albuquerque, NM (US)); Knapp, J.A.; Pope, L.E. pp. 524 of New materials approaches to tribology: Theory and applications. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

The changes in friction and wear properties (i.e., tribology) of steels due to thin surface alloys formed by ion beams are surveyed, and considered in light of their microstructures. Amorphous alloys containing both Ti and C are found to give superior performance in comparison to alloys with N, B, C, P, or Ti. All the amorphous layers reduce friction, but the duration of benefits and wear resistance at high loads vary with composition. By examining similar amorphous alloys with Ti alone or C alone, the critical roles played by each in resisting wear are demonstrated. Amorphous alloys with Ti and C appear to be quite hard.

28422 Surface mechanical properties of Ti alloys produced by excimer laser mixing of Ti on AISI 304 stainless steel. Jervis, T.R. (Los Alamos National Lab., Los Alamos, NM (USA)); Hirvonen, J.-P.; Nastrasi, M.; Zocco, T.G.; Martin, J.A.; Pharr, G.M.; Oliver, W.C. pp. 524 of New materials approaches to tribology: Theory and applications. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-36;AC05-76OR00033. (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

The authors report their investigation of the properties of surface alloys of Ti overlayers on AISI 304 stainless steel substrates. The thickness of the initial Ti surface layers and the fluence and number of pulses used to mix the surface were varied to investigate a broad range of processing conditions. Samples were uniformly translated at different speeds under repetitive pulses of homogenized laser radiation at 308 nm to vary the number of pulses incident on the sample. The authors investigated the surface structure and composition, the wear and friction behavior, and the surface hardness of the resulting alloys. The extent of mixing is observed by Rutherford backscattering spectroscopy to be proportional to the number of pulses incident on the sample. Amorphous surface layers are formed at some mixing levels with a composition which indicates that Ti substitutes for Fe in the stainless steel on a one to one basis. Incorporation of C from surface and the interface contamination is observed but a level much below that found in comparable ion implanted materials.

28423 Coherency strain modeling of elastic moduli in Cu/Nb multilayers. Jankowski, A.F. (Lawrence Livermore National Lab.., Chemistry and Materials Science, Livermore, CA (US)). pp. 471 of Atomic scale calculations in materials science. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8811147–: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

An anomalous decrease in the elastic moduli of Cu/Nb multilayers has been observed via acoustic wave measurements. The decrease occurs for (111) fcc Cu and (110) bcc Nb layered structures with repeat periods between 1 and 5 nm. The coherency strain model has been used to simulate modulus enhancement in noble/transition metal multilayers. This approach addresses the atomic displacements corresponding with the lattice distortions of biaxially stressed layers. Elastic moduli are derived with respect to higher order differentials of a Born-Mayer type potential for nearest neighbor ions. The elastic moduli anomalies of Cu/Nb multilayers are modelled within this conceptual framework.

28424 Molecular dynamics simulation of a $\Sigma = 5$ aluminum bicrystal. Campos, V. (Univ. of Arizona, Dept. of Materials Science, Tucson, AZ (US)); Deymier, P.A. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

A constant pressure molecular-dynamics technique is used to simulate aluminum bicrystals. The ion-ion pair potential is obtained from second order pseudopotential theory and is explicitly electron density dependent. The total cohesive energy of a metal also includes a structurally independent term which is electron density dependent. The density dependence of the total cohesive energy is carried through in the lagrangian equations of motion, so the dynamics of the simulation explicitly contains global pressure and temperature. Temperatures up to the bulk melting point are explored in a $\Sigma = 5$ symmetric tilt aluminum bicrystal.

28425 Differences between the atomic structures of grain boundaries in pure F.C.C. metals and Li_2 ordered compounds. Vitek, V. (Dept. of Materials Science and Engineering, Univ. of Pennsylvania, Philadelphia, PA (US)); Kruisman, J.J.; Hosson, J.TH.M. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh,PA(USA) (1988). (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

Atomic structure of [001] tilt boundaries in an ordered A_3B compound with Li_2 structure has been studied using model pair-potentials to describe atomic interactions. The structural features related to the ordering tendency as well as structural changes associated with deviations away from stoichiometry have been investigated. The differences between boundary structures in pure metals and compounds have been found to be most pronounced when the stoichiometry is preserved at the boundary. Possible significance of these structural aspects for understanding very different fracture behavior of pure f.c.c. metals and Li_2 compounds is discussed.

28426 Photoluminescence studies of InGaAlAs quaternary alloys. Jones, E.D. (Sandia National Labs., Albuquerque, NM (US)); Dawson, L.R. vp. of Spectroscopic characterization techniques for semiconductor technology. Glembocki, O.J.; Pollak, F.H.; Ponce, F. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). (CONF-8803147–: Spectroscopic characterization techniques for semiconductor technology III, Newport Beach, CA (USA), 14-15 Mar 1988).

In this paper photoluminescence data are used to obtain the concentration and temperature dependence of the bandgap energies of epitaxial layers of quaternary alloy In Ga Al As Al concentrations less than 0.6. The samples were grown by MBE without an intervening buffer layer. For an In concentration of 0.1, the transition from a direct to an indirect bandgap material occurs at Al concentration of about 0.5. Coefficients of the temperature dependence of the bandgap energy are presented.

28427 Properties of liquid As: A first principles calculation. Li, X.P (Dept.. of Physics, State Univ. of New York at Stony Brook, Stony Brook, NY (US)); Allen, P.B.; Car, R.; Parrinello, M. pp. 471 of Atomic scale calculations in materials science. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1989). Grant DMR84-20308. (CONF-8811147–: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

The structural and electronic properties of liquid arsenic are calculated using density-functional quantum theory to calculate forces and trajectories of atoms. A semiconducting gap of 0.4 eV is found, and a coordination number of 2.8, close to the experimental values of 0.5 eV and 3. The authors' results support the existence of a Peirls-type distortion in liquid arsenic.

28428 Vibrational localization and vibrational spectra in amorphous silicon. Biswas, R (Microelectronics Research Center, Iowa State Univ., Ames, IA (US)); Bouchard, A.M.; Soukoulis, C.M.; Kamitakahara, W.A.; Grest, G.S. pp. 471 of Atomic scale calculations in materials science. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-82. (CONF-8811147–: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

Amorphous silicon structures have been generated by quenching liquid silicon configurations using molecular-dynamics simulations. Localized vibrational modes have been identified in these models. The presence of under- coordinated atoms in these a-Si models leads to extra resonant modes at low frequencies. The vibrational

densities of states, and dynamic structure factors for localized, resonant and extended modes, are discussed and compared with neutron scattering data. The amorphous networks have also been adapted to model amorphous silicon-germanium systems. Densities of states and localization characteristics have been calculated for a-Si_xGe_{1-x} alloys and a-Si/a-Ge superlattices, and are compared to Raman measurements.

28429 Grain boundary segregation in a two dimensional lattice gas model. Farkas, D. (Dept. of Materials Engineering, VPI and SU Blacksburg, Va. (US)); Jang, H. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

A two dimensional lattice gas model of a binary ordering alloy system was used to study the segregation and the atomic configuration near a $\Sigma = 5$ grain boundary. The cluster variation calculation was performed to study the segregation of alloying elements in the grain boundary region. The present model allows the study of different ordering configurations in the grain boundary region as well as the segregation effect in the vicinity of the grain boundary. The results show that there will be segregation effects and that they can be significant. It is essential that the segregation and disordering effects be considered when high temperature properties of grain boundaries in ordered alloys are studied. The type of segregation observed depends on energic assumptions used in the calculation and on the rigid body translational state of the boundary.

28430 Microstructure of metastable metallic alloy films produced by laser breakdown chemical vapor deposition and ion implantation. Menon, S.K. (Texas Eastern Engineering Ltd., Houston, TX (USA)); Jervis, T.R.; Nastasi, M. pp. 462 of Science and technology of rapidly quenched alloys. Tenhover, M.; Johnson, W.L.; Tanner, L.E. Materials Research Society, Pittsburgh, PA (USA) (1987). (CONF-861207–: Materials Research Society fall meeting, Boston, MA (USA), 1-5 Dec 1986).

The authors report on thin films produced by laser breakdown chemical vapor deposition from nickel and iron carbonyls and by implanting Ni foils with varying levels of characterized by transmission electron microscopy. Decomposition of $Ni(CO)_4$ produced polycrystalline films of fcc Ni and metastable ordered hexagonal Ni_3C. This metastable phase is identical to that produced by gas carburization, rapid solidification of Ni-C melts, and ion implantation of C into Ni at low concentration. Increasing the H_2 content in the gas mixture during laser deposition reduces the grain size of the films significantly with grain sizes smaller than 10 nanometers produced. Laser decomposition of $Fe(CO)_5$ produces films with islands of fcc gamma-Fe and finely dispersed metastable Fe_2O_3 and Fe_3O_4 were found in these samples. Implants of C into pure Ni foils at 77°K and at a concentration of 35 at.% produced amorphous layers. Implants at the same dose at room temperature did not produce amorphous layers.

28431 High-temperature behavior of grain boundaries from embedded atom method molecular dynamics simulation. Lutski, J.F. (Materials Science Div., Argonne National Lab.., Argonne, IL (US)); Wolf, D.; Phillpot, S.R. pp. 471 of Atomic scale calculations in materials science. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-31-109-ENG-38. (CONF-8811147–: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

The behavior of a metallic grain boundary at high temperatures is studied using an embedded atom potential. A recently developed molecular dynamics code is used which allows the simulation of an isolated grain boundary at temperatures as high as the bulk melting point. The stability of the boundary below the melting point is studied and compared with earlier investigations which have suggested the existence of a premelting transition. It is found that the boundary migrates at high temperature but remains well defined up to the bulk melting point. In contrast to simulations of ideal crystals, it was not possible to superheat the grain boundary due to the nucleation of bulk melting at the boundary.

28432 Atomistic simulations of interface in metals and alloys. Chen, S.P. (Theoretical Div., Los Alamos National Lab.., Los Alamos, NM (US)). pp. 471 of Atomic scale calculations in materials science. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811147–: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

The authors have used embedded atom potentials to simulate the surfaces, thin films and grain boundaries in metals (Ni and Al) and alloys (NiAl and Ni_3Al). The calculated surface relaxations and ripplings of free surfaces are in good agreement with experiments. A new interference phenomena of interlayer relaxation in thin films are observed in the simulation. The segregation behavior of B and S and their effects on the mechanical properties of Ni_3Al are correctly predicted with potentials fitted to data obtained by electronic band structure calculations.

28433 Atomistic studies of interfacial structure and properties. Foiles, S.M. (Sandia National Lab., Livermore, CA (US)); Baskes, M.I.; Daw, M.S. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

The computer simulation of the structure and fracture of interfaces on an atomic scale requires a computationally efficient prescription for the total energy that is reliable both for small deviations for the bulk as well as for the free surfaces produced during fracture. The recently developed Embedded Atom Method is such a method. It is briefly described and compared to traditional pair interaction approaches. In particular, it will be shown that the many-body effects inherent in the Embedded Atom Method are essential to correctly describe the experimentally observed surface reconstruction of Au surfaces. The necessary first step in simulating the fracture of an interface, such as a grain boundary, is the determination of the initial or equilibrium atomic configuration of the interface. Equilibrium Monte Carlo simulations using the Embedded Atom Method can determine this structure. This approach is outlined and various results for grain boundary structure in fcc metals will be presented. The atomic structure of symmetric tilt boundaries is found to be significantly different from that deduced from energy minimization techniques. In addition, the Monte Carlo technique allows for the determination of thermal effects such as the vibrational amplitudes at the interface and the thermal expansion of the interface.

28434 Interaction of slip with grain boundary in the Li_2 ordered structure - A $\Sigma = 9$ tilt boundary. Yoo, M.H. (Metals and Ceramics Div, Oak Ridge National Lab., Oak Ridge, TN (US)); King, A.H. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

The role of slip/grain boundary interaction in intergranular fracture has been analyzed for a $\Sigma = 9$ tilt boundary in Li_2 ordered alloys by use of the anisotropic elasticity theory of dislocations and fracture. Screw superpartials cross slip easily at the boundary onto the $(1\bar{1}1)$ and the (001) planes for low and high temperatures, respectively. Transmission of primary slip dislocations onto the conjugate slip system occurs with some difficulty, which is eased by localized disordering. Unless a symmetric double pile-up occurs simultaneously, cleavage fracture is predicted to occur on the $(\bar{1}$ 11) plane, not intergranular fracture. Absorption (or emission) of superpartials occurs only when the boundary region is disordered. The inherent weakness of grain boundaries in Ni_3Al and its improvement by boron segregation are discussed.

28435 Theoretical studies of grain boundaries in Ni, Al, and Ni_3Al with and without boron. Chen, S.P. (Los Alamos National Lab., Los Alamos, NM (US)); Voter, A.F.; Albers, R.C.; Boring, A.M.; Hay, P.J. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

Atomistic simulations of [001] symmetric tilt grain boundaries in Ni, Al, and Ni_3Al are presented. The atomistic structures of the simulated grain boundaries have been analyzed in terms of the structural unit model, which is found to be of limited utility for intermetallics. Simulation to fee surfaces, and strengthens the grain boundary. Good cohesive properties of the grain boundaries occur when both boron and some segregated Ni are presented. The Ni and B are found to co-segregate to the Ni_3Al boundary with an energy advantage of ~ 0.5 eV.

28436 Grain boundary softening in boron-doped Ni_3Al. Qian, X. R. (Lehigh Univ., Dept. of Materials Science and Engineering, Bethlehem, PA (USA)); Chou, Y. T. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

The effect of 0.2 at .% boron on grain boundary hardness in Ni_3Al containing 24 to 26 at .% Al was studied. Normal grain boundary hardening was observed in all alloys with and without boron. However, the addition of boron decreased the magnitude of the grain boundary hardness, and the degree of "softening" depends on alloy stoichiometry. The occurence of boron-induced softening is likely due to the increase in mobility of grain boundary dislocations.

28437 Impurity-induced in interfacial strength and their role in creep fracture. George, E.P. (Oak Ridge National Lab., Metals and Ceramics Div. (USA)); Pope, D.P. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract AC05-84OR21400. (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

Creep cavity nucleation at second phase particles in iron and steel is examined in the light of recent theoretical and experimental results. Theoretical considerations show it to be experimental results. Theoretical considerations show it to be extremely unlikely that thermal nucleation will occur at Fe_3C, FeO or Al_3 particles, or that a thermal nucleation will take place at Fe_3C particles. Consistent with this, it is experimentally found that carbides and oxides almost never nucleate cavities in iron and steel, as long as harmful impurities like sulfur are not present. In the presence of segregated impurities like sulfur, oxides do nucleate cavities, but there is insufficient data to determine whether this is because the impurities make thermal or athermal nucleation easier. Finally, sulfides are thought to be nonwetting in iron and steel. As a result, there should be no barrier to thermal nucleation at sulfides and experiments show that sulfides do nucleate cavities with great ease in iron and steel.

28438 Carbon segregation induced grain boundary embrittlement. Gerberich, W.W. (Dept. of Chemical Engineering and Materials Science, Univ., of Minnesota, Minneapolis, MN (USA)); Chen, X.; Caretta, R. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

To investigate the mechanisms of grain boundary embrittlement, sustained load tests were conducted on a medium carbon, high strength martensitic steel at slightly elevated temperatures. Slow crack growth was observed 185°C to 500°C. Fracture surfaces of the specimens tested were examined by scanning electron microscopy after sustained load tests. It was found that severe grain boundary embrittlement occurred in this material with the predominant fractographic feature being intergranular fracture. Auger electron and x-ray photoelectron spectroscopy of the intergranular facets were utilized to analyze the embrittling species. Prior suggestions for this "strain-aging embrittlement" phenomena have centered around carbide precipitation. The present results suggest that it is carbon, driven by thermal energy and the stress field, that segregates on the grain boundaries and weakens them.

28439 Melt-spun permanent magnet alloy with enhanced isotropic remanence. Kadin, A.M. (Ovonic Synthetic Materials Co., Troy, MI (USA)); Clemente, G.B.; Keem, J.E.; McCallum, R.M. pp. 462 of Science and technology of rapidly quenched alloys. Tenhover, M.; Johnson, W.L.; Tanner, L.E. Materials Research Society, Pittsburgh, PA (USA) (1987). (CONF-861207–: Materials Research Society fall meeting, Boston, MA (USA), 1-5 Dec 1986).

The authors report rapid solidification onto a copper quench surface (melt-spinning) has used to fabricate a high-performance permanent magnet allow (Ovonic Hi-Rem™) based on the Nd-Fe-B class of materials. Crucial additions of alloying elements are combined with careful control over quench parameters to yield a random assembly of microcrystallites, with macroscopically isotropic magnetic properties including values of remanent induction that can exceed 10kG and maximum energy products greater than 20 MGOe. These values exceed those expected from conventional randomly oriented magnets. The enhanced magnetic performance is related to results of x-ray diffraction and electron microscopy.

28440 Electronic structure of extended defects in close-packed metals. Crampin, S. (The Blackett Lab.., Imperial College, London SW7 2BZ (GB)); Vvedensky, D.D.; Maclaren, J.M.; Eberhart, M.E. pp. 471 of Atomic scale calculations in materials science. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1987). (CONF-8811147–: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

Stacking faults in close-packed metals are known to play a crucial role in determining mechanical behavior. Extending recent layer Korringa-Kohn-Rostoker calculations on twin faults in a variety of FCC crystals, the authors study in detail the aluminum defect and develop an atomistic understanding of the modifying behavior of small concentrations of impurity atoms.

28441 The bonding of fluorinated and hydrogenated ethers to metal surfaces: A surface science approach to tribology. Walczak, M.M. (Dept. of Chemistry and Ames Lab., Iowa State Univ., Ames, Iowa (US)); Leavitt, P.K.; Thiel, P.A. pp. 524 of New materials approaches to tribology: Theory and applications. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-82. (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

The authors report a surface science study of fluorinated and hydrogenated ethers adsorbed at a metal surface. Fluorinated ethers bond less strongly to ruthenium surfaces than the hydrogenated analogs, both for atomically-smooth and atomically-rough surfaces. For the hydrogenated ethers, 0.03 to 0.17 monolayers undergo decomposition, while fluorinated ethers do not decompose significantly.

28442 The influence of boron on the ductile-brittle transition in FE-MN steels. Strum, M.J. (Lawrence Livermore National Lab., Livermore, CA (US)); Hwang, S.K.; Morris, J.W. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

Given the recent interest in the element boron as an intergranular "glue" in intermetallics it is important to recognize that it also has a strong effect on intergranular fracture in more conventional structural alloys. The best documented examples are Fe-Mn alloys. It was shown some years ago that the introduction of a minor alloying addition of boron can reduce the ductile-brittle transition of Fe-12Mn ferritic steel by nearly 200 degrees centigrade, more recent work has shown similar results in austenitic Fe-Mn steels. The effect is due to the suppression of intergranular fracture. The basic mechanism has been worked out in some detail and will be described.

28443 Characterization and statistical distribution of grain boundaries in Ni_3Al. Farkas, D. (Dept. of Materials Engineering, Virginia Polytechnic Institute, Blacksburg, VA (US)); Jang, H.; Lewus, M.O.; Versaci, R.; Savino, E.J. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

Grain Boundaries in two specimens of Ni_3Al of different compositions and mechanical behavior were studied by electron microscopy. SEM was used to determine the distribution of Σ values in both samples. TEM results were combined with CSL theory to completely characterize the nature of the boundaries, including Σ values and the grain boundary plane orientation. The boundaries most commonly observed in the experiments were also studied using a computer simulation technique and the results correlated with the experimental observations.

28444 Grain boundary characterization in Ni_3Al. Mackenzie, R.A.D. (Cornell Univ., Dept. of Materials Science and Engineering, Bard Hall, Itaca, NY (US)); Sass, S.L.; Vaudin, M.D. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

Grain boundaries in both pure and boron doped Ni_3Al have been studied using a variety of electron microscopy techniques. Small angle boundary structures were examined in both bicrystal and polycrystalline specimens. Dislocations with Burgers vector a/2⟩110⟨ are observed in the presence of boron, while dislocations with Burgers vector a ⟩100⟨ are observed in the absence of boron. A possible explanation for this behaviour is the presence of a disordered layer at the interface in boron doped Ni_3Al. The addition of boron to Ni_3Al was seen to induce faceting of grain boundaries, and to afford the boundaries some protection from etching. Using electron backscatter diffraction patterns, the frequency of occurrence of grain boundary types was found to be unchanged by the addition of boron.

28445 Anisotropic exchange and superconductivity in UPt_3. Norman, M.R. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)). *Physical Review, B: Condensed Matter (USA),* 41(1): 170-177 (1 Jan 1990). DOE Contract W-31-109-ENG-38.

In this paper an anisotropic exchange interaction is derived and separately fit to high- and low-frequency magnetic neutron scattering data of UPt_3. This information is used to construct a superconducting pair potential in the strong spin-orbit coupling limit. Solutions of the gap equations show that both high- and low-frequency fluctuations support an A_{1u} order parameter, which differ in their vector orientation. Implications of these results in relation to the unique phase diagram UPt_3 will be discussed.

28446 Surface melting of Ni(110). Chen, E.T. (School of Physics, Georgia Institute of Technology, Atlanta, Georgia 30332 (US)); Barnett, R.N.; Landman, U. *Physical Review, B: Condensed Matter (USA),* 41(1): 439-450 (1 Jan 1990). DOE Contract FG05-86ER45234.

Disordering and melting of the surface of Ni(110) are investigated using molecular-dynamics simulations, in which the embedded-atom theory is used to describe the energetics and interatomic interactions. The surface region disorders at temperatures as low as 1450 K via the generation of vacancies accompanied by the formation of an adlayer. The development of a quasiliquid region exhibiting liquidlike energetic, structural, and transport properties, and whose thickness increases as the temperature approaches the melting point, is observed. It is concluded that the premelting of the surface occurs at $T \gtrsim 1700$ K.

28447 Magnetic properties of ultrathin fcc Fe(111)/Ru(0001) films. Liu, C. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)); Bader, S.D. *Physical Review, B: Condensed Matter (USA),* 41(1): 553-556 (1 Jan 1990). DOE Contract W-31-109-ENG-38.

In situ polar and longitudinal Kerr-effect measurements have been used in conjunction with low-energy electron diffraction and Auger characterizations to study the magnetic properties of Fe(111)/Ru(0001). Ru(0001) provides the opportunity to grow fcc Fe with a dilated lattice spacing that is expected to be ferromagnetic. Ferromagnetism is detected, but only for films thicker than ~2 monolayers. The easy axis of magnetization is perpendicular for films <4.5 monolayers thick and becomes in plane for thicker films. The dead layers at the interface are attributed to *d*-band hybridization between the Fe and Ru.

28448 Pressure effects on the martensitic transformation in metallic lithium. Smith, H.G. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831 (USA)); Berliner, R.; Jorgensen, J.D.; Nielsen, M.; Trivisonno, J. *Physical Review, B: Condensed Matter (USA),* 41(2): 1231-1234 (15 Jan 1990). DOE Contract AC05-84OR21400;W-31-109-ENG-38.

High-resolution neutron-diffraction experiments have been performed on polycrystalline lithium-7 metal over a temperature and pressure range of 45 to 300 K and 1 bar to 6.5 kbar. The partial transition from the bcc phase to the 9*R*(Sm type) phase occurred at approximately 90 K at 6.5 kbar, about 15 K higher than the similar transition at 1 bar. On warming at 6.5 kbar, the 9*R* phase transformed to the fcc phase over a narrow temperature range near 140 K. Above 175 K only the bcc phase was present. Single-crystal measurements confirm the 9*R* to fcc transition even at atmospheric pressure.

28449 Neutron diffraction and transmission electron microscopy study of hydrogen-induced phase transformations in Zr_3Al. Meng, W.J. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)); Faber, J. Jr.; Okamoto, P.R.; Rehn, L.E.; Kestel, B.J.; Hitterman, R.L. *Journal of Applied Physics (USA),* 67(3): 1312-1319 (1 Feb 1990). DOE Contract W-31-109-ENG-38.

Hydrogen-induced phase transformations of the equilibrium intermetallic compound Zr_3Al have been studied by *in situ* elastic neutron scattering, x-ray diffraction, and transmission electron microscopy (TEM). TEM observations reveal two distinct modes of amorphous phase formation in Zr_3Al upon hydrogenation, namely, heterogeneous nucleation at preexisting grain boundaries, and homogeneous nucleation within single-crystal grains. *In situ* neutron diffraction reveals a phase separation between a hydrogen (deuterium) poor and a hydrogen (deuterium) rich crystalline phase. Rietveld profile refinement of the neutron diffraction data indicates predominant hydrogen (deuterium) occupation of the octahedral interstitial sites in the crystalline matrix that have only Zr nearest-neighbor atoms. The two different modes of amorphous phase nucleation are directly related to the degree of hydrogen dissolution in the host crystalline matrix.

28450 Deuterium permeability in gold determined using ion beams. Myers, S.M. (Sandia National Laboratories, Division 1112, Albuquerque, New Mexico 87185-5800 (US)); Swansiger, W.A. *Journal of Applied Physics (USA),* 67(3): 1334-1339 (1 Feb 1990). DOE Contract AC04-76DP00789.

The permeability of deuterium (D) in Au was determined by first ion implanting reactive oxygen sinks and then using the nuclear reaction $D(^3He,p)^4He$ to monitor D accumulation in the sinks during D_2 exposure. Results were obtained for temperatures of 573 and 373 K. Previous measurements of the lattice permeability using standard foil-permeation methods extended down only to 523 K, and consequently the present ion-beam study expanded the range of available permeability data by 5 orders of magnitude. We also carried out standard foil-permeation experiments in the temperature range 688–768 K for purposes of comparison with earlier work. When combined with previously published data, our results indicate that the permeability of D in Au has an Arrhenius temperature dependence over 10 orders of magnitude from 373 to 913 K.

28451 Effects of presulfidization on the selectivity and surface structure of ruthenium catalysts. Cocco, R.A. (Auburn Univ., AL (USA)); Tatarchuk, B.J. *Langmuir (USA),* 5(6): 1309-1315 (Nov-Dec 1989).

X-ray photoelectron spectroscopy and static secondary ion mass spectrometry have been used to reveal details about the adsorption sites and surfaces phases which are formed on ruthenium catalysts following pretreatment in H_2-rich or H_2S-rich sulfidization mixtures. Little or no irreversible hydrogen adsorption is measured over metallic ruthenium surfaces retaining { >=} 0.25 monolayer of strongly bound sulfur or over bulk RuS_2 materials sulfided in < 80% H_2s/H_2 at 673 K.

28452 Effect of fluid flow on corrosion fatigue initiation of aluminum alloy 2017-T4. Huang, Y.H. (El Tech Research Corp., Fairport Harbor, OH (US)); Alkire, R.C. *Journal of the Electrochemical Society (USA),* 136(9): 2763-2764 (Sep 1989).

The presence of corrosive environments, particularly chloride-containing solutions, usually lowers the fatigue resistance of metals by speeding the process of crack initiation. Such cracking phenomena generally initiate at corrosion pits which, for many aluminum alloys, serve as stress concentrators once they reach a critical size of some 40 to 50 μ. A growing body of empirical information is being reported on the effect of convective mass transport on early stages of pitting corrosion. This paper reports on the effect of fluid flow on corrosion fatigue crack initiation.

28453 A mathematical model for anomalous codeposition of nickel-iron on a rotating disk electrode. Hessami, S. (Dept. of Chemical Engineering and Lawrence Berkeley Lab., Univ., of California, Berkeley, CA (US)); Tobias, C.W. *Journal of the Electrochemical Society (USA),* 36(12): 3611-3615 (Dec 1989). DOE Contract AC03-76SF00098.

A mathematical model for anomalous alloy deposition onto a rotating disk electrode has been developed. The convective diffusion equations, couples with the homogeneous dissociation reactions of water and metal-hydroxide ions, are numerically solved, and the calculated interfacial concentrations are used to describe the electrode processes. The role of metal-hydroxide ions in the deposition of single metals, reported by other researchers, is extended to codeposition. The kinetic parameters of the alloy deposition are assumed to be the same as those of the single metals involving the discharge of both metal and metal-hydroxide ions; however, during codeposition, the metal-hydroxide ions are allowed to discharge only at a fraction of surface sites proportional to their interfacial concentration. The simulation was applied to the electro-deposition of nickel-iron. In agreement with the experimental observations reported in the literature, the percentage of iron in the deposit is much higher than in the electrolyte, and goes through a maximum as a funciton of applied potential. The estimated effect of agitation on alloy composition and current efficiency is in qualitative agreement with experiments. The model also predicts that while the polarization behavior of nickel is shifted to more cathodic values during code-position, the iron behavior shows no significant change.

28454 The welding metallurgy of Custom Age 625 PLUS alloy. Cieslak, M.J. (Sandia National Labs., Alburquerque, NM (US)); Headley, T.J.; Frank, R.B. *Welding Journal (Miami) (USA),* 68(12): 4735-4825 (Dec 1989). DOE Contract AC04-76DP00789.

The authors discuss the welding metallurgy (solidification behavior, mechanical properties of weld metal, and susceptibility to fusion zone hot cracking) of Carpenter Custom Age 625 PLUS alloy. This alloy solidifies to a nickel austenitic matrix with the formation of a Nb-rich γ/Laves terminal solidification constituent. The low Si and C concentrations in combination with a lower Nb content (3.4wt-%) in this alloy result in a relatively small volume fraction of eutectic constituent relative to that previously observed in Alloy 718. Because of the low volume fraction of eutectic constituent, this alloy has better weldability than Alloy 718. In addition to Laves phase, γ was observed adjacent to Laves phase γ was observed adjacent to Laves in the fusion zone microstructure of the new alloy. Weld metal strengths approximately equal to aged wrought product can be achieved by direct aging of welds.

28455 Weld pool development during GTA and laser beam welding of Type 304 stainless steel: Part II-experimental correlation. Zacharia, T. (Metals and Ceramics Div., Oak Ridge National Lab, Oak Ridge, TN (USA)); David, S.A.; Vitek, J.M.; Debroy, T. *Welding Journal (Miami) (USA),* 68(12): 5105-5185 (Dec 1989). DOE Contract AC05-84OR21400.

In part I of the paper, the results of the heat flow and the fluid flow analysis were presented. Here, in Part II of the paper, predictions of the computational model are verified by comparing the numerically predicted and experimentally observed fusion zone size and shape. Stationary gas tungsten arc and laser beam welds were made on Type 304 stainless steel for different times to provide a variety of solidification conditions such as cooling rate and temperature gradient. Calculated temperatures and cooling rates are correlated with the experimentally observed fusion zone structure. In addition, the effect of sulfur on GTA weld penetration was quantitatively evaluated by considering two heats of 304 stainless steel containing 90 and 240 ppm sulfur. Sulfur, as expected, increased the depth/width ratio by altering the surface tension gradient driven flow in the weld pool.

28456 Weld pool development during GTA and laser beam welding of Type 304 stainless steel: Part I - theoretical analysis. Zacharia, T. (Metals and Ceramics Div., Oak Ridge National Lab., Oak Ridge, TN (USA)); David, S.A.; Vitek, J.M.; Debroy, T. *Welding Journal (Miami) (USA),* 68(12): 499s-509s (Dec 1989). DOE Contract AC05-84OR21400.

A computational and experimental study was carried out to quantitatively understand the influence of the heat flow and the fluid flow in the transient development of the weld pool during gas tungsten arc (GTA) and laser beam welding of Type 304 stainless steel. Stationary gas tungsten arc and laser beam welds were made on two heats of Type 304 austenitic stainless steels containing 90 ppm sulfur and 240 ppm sulfur. A transient heat transfer model was utilized to simulate the heat flow and fluid flow in the weld pool. In this paper, the results of the heat flow and fluid flow analysis are presented.

28457 Electrodeposition of amorphous ternary nickel-chromium-phosphorus alloy. Guilinger, T.R. To Dept. of Energy, Washington, DC. USA Patent 4892628/A/. 9 Jan 1990. Filed date 14 Apr 1989. USA Patent Application 7338013. Int. Cl. C25D 3/56. vp.

This patent describes a method of forming amorphous ternary nickel-phosphorus-chromium alloy deposits by electrodeposition on an electrically conductive substrate. It comprises: subjecting the substrate to an applied current density between about 20 and 40 A/dm^2 at a temperature from the range of about 20° to 30°C in a bath. The bath comprising: a chromium salt and a nickel salt in a weight ratio of about 3:1, a phosphorus source at about 0.3 MP concentration; about 0.3 M of a complexing agent; about 0.1 M of a supporting salt; and about 1.0 M of buffer.

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Refer also to citation(s) 27428, 27655, 27752, 27839, 27842, 27901, 27902, 27903, 27904, 27905, 27906, 27907, 27908, 27909, 27910, 27911, 27912, 27913, 27914, 27927, 27936, 28105, 28115, 28223, 28370, 28376, 28388, 28393, 28394, 28413, 28549, 28614, 28616, 28619, 28622, 28624, 28630, 28631, 28632, 28633, 28634, 28635, 28636, 28639, 28641, 28643, 28730, 28748, 28760, 28775, 28780, 28782, 28783, 28790, 29592, 29594, 29597

28458 (AD-A–216507/4/XAB) **Pulsed-laser deposition of high-t_c superconducting thin films. Final technical report, 15 November 1988-15 October 1989.** Boyce, J.B.; Connell, G.A. Xerox Palo Alto Research Center, CA (USA). 20 Dec 1989. 5p. Available from NTIS, PC A01/MF A01.

Superconducting thin films have been deposited in-situ on several substrate materials using pulsed excimer laser deposition. On the standard oxide substrates, excellent films were obtained. They had high transition temperatures with narrow transition widths, metallic conductivity in the normal state, low room-temperature resistivity, high critical currents, c-axis orientation, and epitaxial alignment with the substrate. On the more technologically relevant substrates of sapphire and silicon, world record, though less optimal, results were obtained. The transition temperatures were high and metallic conductivity was obtained in the normal state. However, the room-temperature and microwave surface resistivities were higher and the critical currents lower than for the above substrates. These diminished transport properties correlate with the imperfect alignment and epitaxy of the superconductor substrate. For silicon substrates, a buffer layer is required due to high reactivity even at low temperatures. The best results were obtained on clean, hydrogen-terminated surfaces rather than oxidized silicon. Epitaxial alignment was achieved, but there was a substantial spread in orientations, accounting for the diminished transport properties.

28459 (AD-A–216687/4/XAB) **Ceramics derived from organo-metallic precursors and microstructure of amorphous polymer. Final report.** Uhlmann, D.R. Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Materials Science and Engineering. Jul 1985. 61p. Available from NTIS, PC A04/MF A01.

This work represented a continuation of our efforts directed to understanding the microstructure of epoxy resin cured with amine hardeners. The focus has been on characterizing a series of networks formed by changing the formulations and the processing conditions of the system. The table on pages shows the Epon 828 epoxy/triethylene tetramine (TETA) formulations which were explored, together with the curing conditions employed. Ceramics from Organo-metallic Precursors: Our investigations of the conversions of organo-metallic precursors to ceramics have directed attention to five principal areas. These were: (1) Investigation of hydrolysis and condensation kinetics of tetratethylorthosilicate (TEOS), an important precursor for many glasses and ceramics; (2) Exploration of the competition between crystallization and viscous sintering, to determine the conditions under which dense glassy bodies or coatings can be obtained; (3) Investigation of the hydrolysis and condensation of of tantalum ethoxide to form coatings of tantalum oxide; (4) Initial exploration of organic modified as novel coatings and bulk materials; and (5) Exploration of the conversion of aluminum alkoxides, most notable aluminum sec butoxide, to aluminum oxide. Progress in the first two of these areas will be described in the present report; progress in the last three will be deferred to a later date.

28460 (AD-A–216695/7/XAB) **Critical-current density and transition-temperature measurements of Y-Ba-Cu-O rods. Memorandum report.** Francavilla, T.L.; Candela, G.A.; Soulen, R.J. Naval Research Lab., Washington, DC (USA). 19 Dec 1989. 35p. (NRL-MR–6534). Available from NTIS, PC A03/MF A01.

Measurements were made on the superconducting properties of cylindrical Y-Ba-Cu-O rods prepared by ICI Americas Inc. The transition temperature was determined from measurements of ac susceptibility as a function of temperature. The critical current density at 77K was determined by measuring the voltage as a function of current using four terminal transport measurements, in magnetic fields of different intensities.

28461 (AD-A–216715/3/XAB) **Colloid and interface chemistry aspects of ceramics. Final technical report, 1 August 1985-31 August 1989.** Matijevic, E. Clarkson Univ., Potsdam, NY (USA). Div. of Research. 29 Nov 1989. 21p. Available from NTIS, PC A03/MF A01.

This comprehensive, long term, interdisciplinary program has a dual purpose: (a) To generate new or better defined dispersed solids as starting materials for controlled microstructures, with special emphasis on electrooptic ceramics, as well as composites that meet armor and antiarmor requirements. (b) To develop a better understanding of interfacial processes responsible for different properties of high performance ceramics. With respect to (a), several powders of simple and mixed composition have been prepared including zirconium, cerium, yttrium, gadolinium, europium, samarium, and terbium compounds. Furthermore, particles of internally mixed composition of Y(III)/Ce(III) and Zr(IV)/Y(III) basic carbonates and oxides in varying molar ratios have been synthesized. Finally, particles of different cores coated with other compounds have been obtained, such as oxides of chromium, iron, and titanium covered with alumina, or of iron oxide coated with zirconia or yttria. The powders so obtained were of narrow size distribution with particles of different morphologies, including spheres. These materials were characterized in terms of their various properties (porosity, optical, magnetic, electrokinetic, etc.). With respect to (b), the studies involved solid/solute and solid/solid interactions. The adsorption of chelating agents on iron oxides was used to affect the surface potential and dissolution of the finely dispersed solids.

28462 (AD-A–216881/3/XAB) **Laboratory for the processing and evaluation of inorganic matrix composites. Annual technical report.** Cornie, J.A. Massachusetts Inst. of Tech., Cambridge, MA (USA). Materials Processing Center. Jun 1989. 192p. Available from NTIS, PC A09/MF A01.

The research program at MIT on the fundamentals of processing of inorganic matrix composites focuses on developing a basic understanding of solidification processing of metal matrix composites and the behavior and modification of interfaces. This understanding is applied to the development of processes for the manufacture of evaluation specimens which are used, in turn, to determine the microstructure/processing/materials properties relationships. Technical areas discussed in this report include: Kinetics of Fiber Preform Infiltration; Infiltration of Fibrous Preforms by a Pure Metal; Intrinsic Toughness of Interfaces Between SiC Coatings and Substrates of Si or C Fiber; Interfaces with Controlled Toughness as Mechanical Fuses to Isolate Fibers from Damage; A High-Resolution Transmission Electron Microscopy Study of the SiC Coated Graphite Fiber/Aluminum Composite; Wetting of Ceramic Particulates with Liquid Aluminum Alloys; Wettability of SiC Particulates with Zn and Zn-Al Alloys; Interface Chemistry of Inorganic Composite Materials; Preparation of Boron-Containing Ceramic Materials by Pyrolisis of the Decaborane(14)-Derived-B10H12-Ph2POPPh2(x)-Polymer; Non-Polymeric Binders for Ceramic Powders: Utilization of Neutral and Ionic Species Derived from Decaborane (14); and Phosphorus-Containing Derivatives of Dacaborane (14) as Precursors to Boron-Containing Materials.

28463 (AD-A–216976/1/XAB) **Search for far-infrared radiation from optically pumped defect modes. Final report, 15 June 1986-30 September 1989.** Sievers, A.J. Cornell Univ., Ithaca, NY (USA). 13 Nov 1989. 62p. Available from NTIS, PC A04/MF A01.

A comprehensive experimental study of the near-millimeter wave dynamics of a variety of solids is being carried out. Since in many cases the investigation involves driving the system far from equilibrium with IR or UV laser radiation, knowledge of the time-dependent optical response over a broad frequency region is required. Effects such as persistent IR spectral hole burning and population inversion in internal vibrational modes in solids have been uncovered using this approach. The discovery that persistent IR hole burning can be used to manipulate the near-millimeter-wave response of defects in crystals, such as $NO_2(-)$:KI, and that it also provides a sensitive probe of the optical photodarkening in chalcogenide glasses have opened up new research avenues which require simultaneous probes of very different frequencies in the IR and visible. On going exploration of the FAR-IR response of high-temperature superconductors in sintered, thin film, single crystal and even single grain form continue to provide new information about the dynamical response of these unusual materials both in the normal and superconducting states.

28464 (BNL–44411) **The efficiencies and error-rates of Euclidean and Mahalanobis searches in hypergeometries of archaeological ceramic compositions.** Harbottle, G. Brookhaven National Lab., Upton, NY (USA). [1990]. 36p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9004166–1: 1990 archaeometry symposium, Heidelberg (Germany, F.R.), 2-6 Apr 1990). Order Number DE90009201. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Underlying all archaeological investigations where provenience is inferred from multivariate analytical characterization is the assumption that the group of objects analyzed form a unique set in multivariate hyperspace. In this paper large archaeological ceramic data sets are used to test this assumption. The results clearly demonstrate the dangers of using too few variates, and the power of multivariate matrix-inversion (Mahalanobis) techniques, in the formation of adequately unique groups.

28465 (CEA-CONF–9962) **A new way of investigation of magnetic field penetration in RBaCuO superconductors by polarised neutron diffraction on rare earth.** Petitgrand, D. (Laboratoire Leon Brillouin, Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (FR)); Gillon, B.; Delapalme, A.; Schweiss, P.; Collin, G. Laboratoire Leon Brillouin, Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). 1989. 2p. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989). Order Number DE90773453. Available from NTIS (US Sales Only), PC A02/MF A01.

A new way for studying the penetration of the magnetic field in RBaCuO-type superconductors is described. The measurement, by polarised neutron scattering, of the magnetic moment induced on the rare-earth by an external field gives direct informations on the penetration of flux lines in the sample. Our results on a single-crystal of $HoBa_2Cu_3O_7$ are discussed in connection with the Bean model and give an estimation of the flux density gradient and of the bulk critical current.

28466 (CONF-891119–120) **Superconducting and semiconducting thin films of La_{123} and Y_{123} and their superlattices.** Ganapathi, L. (North Carolina State Univ., Raleigh, NC (USA). Dept. of Materials Science); Kumar, A.; Narayan, J.; Holland, O.W. Oak Ridge National Lab., TN (USA). [1989]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90009565. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Thin films of La_{123} and their superlattice with Y_{123} are deposited on various substrates for the first time. Thin films of La_{123} can be made semiconducting or superconducting within a small range of oxygen stoichiometry. A multiple target holder has been used for in situ processing of superlattice thin films. The ability of the La_{123} compound to exhibit either semiconductivity or superconductivity has been utilized to construct semiconductor/superconductor superlattice structures with Y_{123}. X-ray diffraction studies have shown clearly the presence of two distinct type layers in the superlattice films with an individual layer thickness of ~120 and 300 Å, although this did not happen for ~24 Å thickness of the individual layers. Rutherford backscattering experiments showed good quality of the films with channeling yields <10%. Resistivity measurements showed a T_c(onset) = 90 K and T_c(zero) = 85 K for the La_{123} as well as superlattice thin films. 16 refs., 5 figs.

28467 (CONF-891119–121) **In-situ processing of epitaxial and textured high $T_c$superconducting $HoBa_2Cu_3O_{7-x}$ thin films by pulsed laser evaporation technique.** Lee, C.B. (North Carolina State Univ., Raleigh, NC (USA). Dept. of Materials Science and Engineering); Prasad, R.; Singh, A.K.; Sharan, S.; Singh, R.K.; Narayan, J.; Holland, O.W.; Boatner, L.A. Oak Ridge National Lab., TN (USA). [1989]. 4p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract AC05-84OR21400. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90009828. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Excellent quality epitaxial and textured superconducting $HoBa_2Cu_3O_{7-x}$(Ho 123) thin films have been fabricated on lattice matched (100) $KTaO_3$ and (100) $LaAlO_3$, and lattice mismatched (100) MgO substrates by the pulsed laser evaporation (PLE) technique. A bulk Ho 123 target was evaporated using nanosecond excimer laser pulses with the evaporating material depositing on a substrate maintained in the temperature range of 550–650°C. The temperature for zero resistance for $HoBa_2Cu_3O_{7-x}$ films deposited on various substrates at 650°C varied between 85 to 89K. The epitaxial films deposited on (100) $LaAlO_3$ substrates exhibited critical current densities greater than 3.5×10^6 Amps/cm^2 at 77 K. The superconducting properties of the Ho 123 films were found to be similar to Y 123 films. 5 refs., 4 figs.

28468 (CONF-891119–122) **In-situ pulsed laser deposition of high-T_c $YBa_2Cu_3O_7$ superconducting thin films on (100) LaA103 substrates.** Tiwari, P. (North Carolina State Univ., Raleigh, NC (USA). Dept. of Materials Science); Sharan, S.; Singh, R.K.; Narayan, J.; Holland, O.W. Oak Ridge National Lab., TN (USA). [1989]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90009861. Available from NTIS, PC A02/MF A01 - OSTI.

The formation of superconducting thin films on lanthanum aluminate substrates is very important for high-frequency applications. In this paper, we discuss the fabrication of epitaxial superconducting $YBa_2Cu_3O_7$ thin films on (100)$LaAlO_3$ substrates, which exhibit excellent dielectric properties required for high frequency applications. The films were deposited by the biased pulsed laser evaporation technique (PLE) at substrate temperatures between 500–650°C and exhibit excellent crystallinity with best minimum ion channeling yields corresponding to approximately 3%. The superconducting transition temperatures varied from 88–92 K with critical current densities at 77K and zero magnetic field greater than $4 - 5 \times 10^6$ Amps/cm^2.

28469 (CONF-900395–1, pp. 5-8) **Systematic preparation of selective heterogeneous catalysts.** Augustine, R.L. (Seton Hall Univ., South Orange, NJ (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. DOE Contract FG02-84ER45120. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

As a synthetic organic chemist with experience in the catalytic hydrogenation of organic functional groups I became interested in the idea that synthetically useful heterogeneously catalyzed reactions other than hydrogenation could be developed but to do this would require a detailed understanding of the nature and specific reactivity of the various types of active sites present on the catalyst surface. Research activities were begun with the aim of developing such an understanding and to use the information produced to extend the usefulness of heterogeneous catalysis in synthetic applications. The most significant aspect of our current research is the development of Frontier Molecular Orbital diagrams for the various reactive sites present on the surface of dispersed metal catalysts. With these diagrams the reactivity of the various types of surface atoms can be rationalized and new catalytic reactions developed.

28470 (CONF-900395–1, pp. 25-29) **Catalytic steam gasification of carbon: Research on tungsten carbide catalysts with high surface area.** Boudart, M. (Stanford Univ., CA (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. DOE Contract FG03-87ER13762. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

Unsupported carbide powders with high specific surface area, namely α-WC (35 m^2 g^{-1}, hexagonal), β-$WC_{0.61}$ (100 m^{2}g^{-1}, cubic face centered) and β-$WC_{0.5}$ (15 m^{2}g^{-1}, a hexagonal) have been prepared. The key element in this preparation is the successful removal of surface polymeric carbon by careful gasification to methane by means of dihydrogen.

28471 (CONF-900395–1, pp. 30-33) **Reactive characterization as a probe of the nature of catalytic sites.** Brenner, A. (Wayne State Univ., Detroit, MI (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

This research program is primarily concerned with achieving a better understanding of the nature of active sites on heterogeneous catalysts. It is extremely rare that the identity of an active site is known for a heterogeneous catalyst. This research program has three main objectives: (1) Prepare and determine the activity of well dispersed and low valent catalysts of base metals. (2) Determine the activity for H_2-D_2 exchange for a variety of transition metals and metal oxides. (3) Develop the concept of reactive characterization to see if it can be used to assess the morphology of catalysts containing very small metal ensembles. Substantial data dealing with objective (1) and partial data for the other objectives have been previously reported. This report will describe results of the past year.

28472 (CONF-900395–1, pp. 34-37) **Model Cu/ZnO catalysts for methanol synthesis: The role of surface structure.** Campbell, C.T. (Univ. of Washington, Seattle (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

Copper/zinc oxide catalysts are highly active and selective for several reactions of importance in energy technologies: methanol synthesis, water-gas shift, and methanol steam reforming. These reactions are studied here using ultrahigh vacuum surface science combined with reaction kinetics at high pressures 1-10^4 torr. These experiments apply surface analytical techniques to investigate the

relationship between catalytic activity and the atomic-level surface structure of model catalysts based on Cu and ZnO single crystals. The structural and electronic properties of adsorbed intermediates are correlated with their kinetic in individual steps, which in turn are compared to the overall reaction rates.

28473 (CONF-900395–1, pp. 56-59) **Infrared study of carbon deposits on bimetallic catalysts.** Eischens, R.P. (Lehigh Univ., Bethlehem, PA (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

Early infrared studies of carbon deposited on Al_2O_3, Pt/Al_2O_3, and $Pt\text{-}Re/Al_2O_3$, by exposure to acetylene at 250°C, indicated that the deposit includes an oxidized species. This species was detected by infrared bands near 1580 and 1470 cm^{-1}. One of the first objectives of the work at Lehigh was to unambiguously determine whether the bands can be assigned to an oxidized species. This was accomplished by depositing coke on alumina in which the oxygens had been replaced with oxygen-18. The 1580 and 1470 cm^{-1} bands were each lowered by about 20 cm^{-1} as expected from substitution of oxygen-18 into a carboxylate.

28474 (CONF-900395–1, pp. 60-63) **Model catalytic oxidation studies using supported monometallic and heterobimetallic oxides.** Ekerdt, J.G. (Univ. of Texas, Austin (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

This research program is directed toward a more fundamental understanding of the effects of catalyst composition and structure on the catalytic properties of metal oxides. A key limitation to developing insight into how oxides function in catalytic reactions is in not having precise information of the surface composition under reaction conditions. To address this problem we propose to develop oxide systems which can be used to model oxide catalysis in a systematic fashion.

28475 (CONF-900395–1, pp. 68-71) **Metal-support bonds in supported metal catalysts.** Gates, B.C. (Univ. of Delaware, Newark (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

This research is an investigation of the synthesis, structure, and bonding of a family of metal complexes and metal aggregated on the surfaces of metal oxide supports. The primary focus is the metal-support interface and the interactions between the metals and the supports. Surface structures have been prepared by the reactions of organometallic precursors with the support surfaces. The precursors are complex of W, Re, Os, Ir, and Pt, including $W(CO)_6$, $HRe(CO)_5$, $Re_2(CO)_{10}$, $H_3Re_3(CO)_{12}$, $H_2Os(CO)_4$, $Ir(\eta\text{-}C_3H_5)_3$, $Pt(\eta\text{-}C_3H_5)_2$, and $Pt(CH_3)_2(COD)$. The supports are primarily MgO and $\gamma\text{-}Al_2O_3$.

28476 (CONF-900395–1, pp. 72-74) **Project summary.** Gerstein, B.C. USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

Our work in heterogeneous catalysis uses nuclear spin dynamics to study catalytically active surfaces, and deposited molecules and molecular fragments on these surfaces. Catalysts include zeolites, vanadium phosphorus oxides, used in the conversion of C_4 hydrocarbons to maleic anhydride, supported bimetallic catalysts such as $Cu\text{-}Ru/SiO_2$ which model catalysts used in petroleum reforming, and alkali metal doped copper oxides, which have been found to convert $CO + H_2$ to higher alcohols.

28477 (CONF-900395–1, pp. 75-79) **The formation of supported bimetallic clusters: The effect of support - Metal precursor interactions.** Gonzalez, R.D. (Univ. of Illinois, Chicago (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

In previous studies, Pt-Ru bimetallic clusters were prepared by coimpregnation using $H_2PtCl_6 \times 6H_2O$ and $RuCl_3$ (1). In that study, the surface composition was found to be enriched in Pt. After careful consideration of the preparative variables, it was concluded that surface enrichment in Pt occurred as a result of the higher surface mobility of the Pt metal precursor. In the case of $H_2Pt\ Cl_6$, a repulsive anionic interaction between the negatively charge silica surface and $PtCl_6^{2-}$ resulted in a very weak metal-precursor-support interaction. Because the aqueous speciation of $RuCl_3$ is predominantly cationic, it is strongly bound to the negatively charged silica support. When the precursors are contacted with flowing hydrogen, Ru centers capable of adsorbing hydrogen are formed first. Surface diffusion of the mobile precursor ($PtCl_6^{2-}$ or $PtCl_4$) to these centers result in nucleation of Pt atop the Ru surface atoms which form a metallic core. The reduction is therefore assisted by the presence of hydrogen chemisorbed atop the Ru centers.

28478 (CONF-900395–1, pp. 84-87) **Support effects studied on model supported catalysts.** Gorte, R.J. (Univ. of Pennsylvania, Philadelphia (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The aim of this research is to understand how an oxide support can modify the catalytic and adsorption properties of a metal or oxide catalyst. Most of our past work on how a support can modify catalytic properties has been for supported, group VIII metals. Our approach to studying this question has been to use low-surface-area, model catalysts, which allow us to use surface sensitive characterization techniques, such as Auger electron spectroscopy (AES) and x-ray photoelectron spectroscopy (XPS), to obtain the surface composition and chemical state of the catalyst. The use of model catalysts also simplifies the interpretation of temperature programmed desorption (TPD) for the characterization of adsorption properties by eliminating diffusion and readsorption effects. The model catalysts we have used in our studies were prepared by vapor deposition of metals onto flat oxide supports. The metal coverages were measured using a quartz-crystal, film thickness monitor.

28479 (CONF-900395–1, pp. 91-93) **Some fundamental aspects of zeolite catalysis.** Hall, W.K. (Univ. of Pittsburgh, PA (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

This research has been directed toward the development of understanding of catalyst acidity and its influence on activity and selectivity in acid catalyzed reactions. Two approaches have been used. The first involved spectroscopic measurements of chemisorbed species to test the ability of various preparations to form carbenium ions and other protonated bases. The second was

through studies of the reactions of model compounds. The motivation was to determine whether or not any of the preparations (mainly zeolites) qualified as super acids.

28480 (CONF-900395–1, pp. 94-97) **A spectroscopic and catalytic investigation of active phase-support interactions.** Haller, G.L. (Yale Univ., New Haven, CT (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

Active catalytic phases (metal, mixed metals, oxide or mixed oxides) interacting with oxide support on which the active phase is dispersed can affect the percentage exposed, the morphology of metal or bimetallic particles, the degree of reducibility of cations, etc., in a variety of ways. Our objective is to characterize the physical chemistry of the active phase-oxide interaction by spectroscopic methods (primarily using the element specific spectroscopies X-ray absorption-XANES/EXAFS- and NMR) and to correlate this structure with catalytic function. An important corollary to this objective is an understanding of the interaction chemistry between the active phase precursors and the oxide supports using the same spectroscopies used to characterize the final active phase.

28481 (CONF-900395–1, pp. 44-47) **Surface studies of ceramics using microbeam methods.** Cowley, J.M. (Arizona State Univ., Tempe (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The dedicated scanning transmission electron microscopy (STEM) instruments provide a range of powerful techniques for the study of surfaces including scanning reflection electron microscopy (SREM), microdiffraction from surface features as small as 1nm in diameter, electron energy loss spectroscopy in the reflection mode (REELS) (1) and high-resolution secondary electron microscopy (HRSEM) (2) with 1nm resolution, with or without energy analysis (8,11). Our earlier studies of the surfaces of MgO crystals and their interactions with thin metal films have served as a means for exploring and demonstrating these techniques for the study of surface structure and at the same time have provided a considerable amount of information on metal-oxide interactions. The techniques have been developed for the preparation of clean surfaces of α-alumina suitable for use in electron-optical surfaces studies. REM and SREM observations have been made of the equilibrium forms of monoatomic and multilayer steps on vicinal (0001) faces and of the interaction of thin Ag and Cu layers with the oxide at the steps and on the step-free terraces.

28482 (CONF-900395–1, pp. 105-108) **Model catalyst studies of active sites and metal/support interactions on vanadia and vanadia-supported catalysts.** Henrich, V.E. (Yale Univ., New Haven, CT (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

This program utilizes single-crystal model catalysts and a variety of surface sensitive electron spectroscopic techniques to study the nature of active sites on the surfaces of vanadias and titanies and the properties of metal catalyst atoms supported on vanadias and titania. Although problems with the installation of our new HREELS spectrometer have prevented us from pursuing one of the main experimental directions proposed in the grant, we have expanded our research program in several directions. The electronic structure of model TiO_2 catalyst support surfaces has been studied by means of a series of photoemission experiments conducted at the National Synchrotron Light Source, Brookhaven National Laboratory.

28483 (CONF-900395–1, pp. 109-111) **Studies of supported hydrodesulfurization catalysts.** Hercules, D.M. (Univ. of Pittsburgh, PA (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The overall objective of the proposal is to investigate the structure/activity relationship for Mo or W based hydrodesulfurization catalysts promoted by Ni or Co and supported on undoped or modified Al_2O_3 and TiO_2 surfaces. Specifically the proposed research focused on the following areas: (1) the study of the mechanism of adsorption of Mo and W oxyanions on Al_2O_3 and TiO_2, (2) Quantitative analysis of the distribution of supported Mo and W species present in the catalysts oxidic precursors, (3) the determination of the distribution of Mo (or W) oxidation states in reduced Mo (or W)/TiO_2 (or Al_2O_3) catalysts and correlation of the results with the catalytic activity for various probe reactions and (4) characterization of the sulfided catalysts and correlation of the Mo and W speciation with HDS activity.

28484 (CONF-900395–1, pp. 135-137) **Structures of transition metal hydrides.** Koetzle, T.F. (Brookhaven National Lab., Upton, NY (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. DOE Contract AC02-76CH00016. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

In this program, structures of catalytically-important transition metal hydrides are being studied by neutron and x-ray diffraction methods. The neutron diffraction studies, which utilize the unique facilities at the Brookhaven High Flux Beam Reactor, provide precise structural data that are essential for understanding the bonding in these compounds. A long-range goal of this research is to improve our knowledge of the role of metal hydride catalysts in such industrially-important processes as hydrogenation reactions and C-H bond activation. Current work emphasizes two classes of hydrides: complexes with intact dihydrogen ligands, and heterometallic systems with M-H-M′ bridge bonds.

28485 (DOE/ER/13604–8) **Model catalytic oxidation studies using supported monometallic and heterobimetallic oxides: Progress report, August 1, 1989–July 31, 1990.** Ekerdt, J.G. Texas Univ., Austin, TX (USA). 20 Apr 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-86ER13604. Order Number DE90009984. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Current research is focused on molybdenum and tungsten oxide overlayers. The research involves characterization of the organometallic deposition process, characterization of the resulting oxides using spectroscopic and structure sensitive molecular probes, and use of these oxides in catalytic studies. Raman, uv-diffuse reflectance, and photoluminescence spectroscopies are used to characterize the coordination and structure of the supported cations. Thermal oxidation/reduction, photochemical reduction in CO, and IR of adsorbed CO are used to study the adsorptive and reductive characteristics of the cations. simple reactions will be used to probe the catalytic properties. These reactions include methanol oxidation, oxidative dehydrogenation of alkanes, oxidation of olefins, and hydrogenolysis of cyclopropane. We will attempt to determine how cation ensemble size rather than crystallographic orientation influences the selectivity and activity of these oxide catalyzed reactions. 2 refs.

28486 (DOE/ER/45204–T4) **Topotactic and epitactic routes to new materials: Progress report.** Roy, R.; Komarneni, S. Pennsylvania State Univ., University Park, PA (USA). Materials Research Lab. Dec 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER45204. Order Number DE90009962. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

While there is a great deal of research on the synthesis of high-temperature glasses and ceramics, there is but little research on new low-temperature materials. The main objective of this research is to synthesize new low-temperature materials which are difficult or impossible to synthesize by traditional solid-state or hydrothermal methods since in many cases these could serve as useful hosts for immobilization of ions and as catalyst substrates. The proposed–and now successfully demonstrated–approach to achieve such syntheses at such low temperatures is to utilize the special advantage conferred by the epitactic and topotactic routes. These have already been shown to be very effective in the previous grant in related reactions.

28487 (DOE/ER/45258–4) **The effects of point defects and composition on structural phase transition: 1989–90 technical report.** Toulouse, J. Lehigh Univ., Bethlehem, PA (USA). Dept. of Physics. [1990]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER45258. Order Number DE90010109. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

During the first three years of this project, we have concentrated our effort on three systems: $KTa_{1-x}Nb_xO_3$, $KZnF_3$:Li and $KMnF_3$:Li. The initial goals of the study were (1) to develop the necessary experimental capabilities, (2) to identify the nature of the defects, (3) to characterize the effect of these defects on the phase transition. These goals have been successfully reached and we now propose to pursue the present research along three lines.

28488 (EGG-M–90043) **Comparison between data generated from "standard" fracture toughness specimens and from nonstandard specimens made of a silicon carbide.** Reuter, W.G.; Lloyd, W.R.; Knibloe, J.R. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-76ID01570. (CONF-9006124–3: Society for Experimental Mechanics conference, Albuquerque, NM (USA), 4-6 Jun 1990). Order Number DE90009621. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The ability of methods based upon linear elastic fracture mechanics to predict the structural integrity of a class of monolithic ceramics was investigated experimentally. Three important assumptions related to the hypothesized methodology are identified for verification. The data and discussion presented in this report provide strong support for all three. Obstacles to be overcome in the final design/assessment of a structural ceramic component are also identified. 7 refs., 4 figs.

28489 (IPPCZ–293/I, pp. 119-128) **Synthesis of ultrafine powders by an inductively coupled plasma.** Klotz, H.-D.; Mach, R.; Drost, H.; Suhrke, K.-D.; Schulz, G.; Schierhorn, E. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

High-temperature gas-phase chemistry under plasma conditions provides an alternative method for the synthesis of ultrafine and very high-purity powders. Two broad classes of plasma reactor design are widely used, i.e., DC arcs and inductively coupled high-frequency systems. The advantages and disadvantages of both reactor types are discussed. In ZIPCH, Berlin an inductive apparatus is used for SiO_2 powder synthesis. A diagram of the reactor is given and results of analyzing the powder by various methods (X-ray diffraction, transmission electron microscopy, IR spectroscopy, sedimental analysis) are presented. (J.U.).

28490 (IPPCZ–293/I, pp. 135-139) **D.C. magnetron sputter deposition of thin films from composite targets.** Lonekova, H. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Fyzikalni Ustav); Musil, J. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

DC magnetron sputtering of ceramic oxides from composite Y-Ba-Cu-O targets was studied experimentally. Due to the different atomic masses of the individual target components and to resputtering of the deposited films by energetic particles, it is difficult to reproduce the stoichiometry of the target in the deposited films. The process can be influenced, however, by the working gas pressure, substrate temperature, deposition voltage and the substrate-to-target distance. The conditions are given under which the Y:Ba:Cu stoichiometry of the films is very close to 1:2:3. (J.U.).

28491 (LA-UR–90-756) **Overview of current bulk and thick film high temperature superconductor processing strategies.** Ott, K.C.; Quinn, R.K. Los Alamos National Lab., NM (USA). [1990]. 12p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-36. (CONF-9006121–4: 4. international SAMPE electronic materials and processes conference, Albuquerque, NM (USA), 12-14 Jun 1990). Order Number DE90008949. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A review of processing strategies to prepare conductor-configured high temperature superconductors is presented along with a tabulation of recent results obtained using a variety of processing procedures to produce wires, tapes, monoliths, and thick films of high temperature superconducting material. 32 refs., 1 tab.

28492 (LA-UR–90-933) **Pulsed laser processing of high temperature superconducting thin films.** Muenchausen, R.E. (Los Alamos National Lab., NM (USA)); Dye, R.C.; Estler, R.C.; Foltyn, S.; Garcia, A.R.; Hubbard, K.M.; Nogar, N.S.; Wu, X.D.; Carim, A.; Mukherjee, A. Los Alamos National Lab., NM (USA). [1990]. 15p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-36. (CONF-9006121–5: 4. international SAMPE electronic materials and processes conference, Albuquerque, NM (USA), 12-14 Jun 1990). Order Number DE90008928. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Systematic studies of the effects of pulsed laser deposition processing parameters on plume dynamics and resultant film properties have been performed. Plume angular distributions, $\cos^m(\theta)$, were observed to be variable between $1 > m > 10$ depending on laser energy density and spot size. Under optimized conditions, epitaxial, superconducting thin films could be grown in-situ on a variety of single-crystal substrates. High quality, 200 nm thick films were obtained at deposition rates approaching 15 nm/sec. Additionally, the patterning of $YBa_2Cu_3O_{7-x}$ thin films has been achieved by a process which combines thermal oxygen diffusion and laser annealing. This process is performed under relatively mild conditions which allows the structural integrity of the films to be preserved. 9 refs., 6 figs.

28493 (N–90-16072) **Thermodynamic analysis of chemical stability of ceramic materials in hydrogen-containing atmospheres at high temperatures. Final report.** Misra, A.K. Sverdrup Technology, Inc., Cleveland, OH (USA). Jan 1990. 26p. (NASA-CR–4271;E–4954;NAS–1.26:4271). Available from NTIS, PC A03/MF A01.

The chemical stability of several ceramic materials in hydrogen-containing environments was analyzed with thermodynamic considerations in mind. Equilibrium calculations were made as a function of temperature, moisture content, and total system pressure. The following ceramic materials were considered in this study: SiC, Si_3N_4, SiO_2, Al_2O_3, mullite, ZrO_2, Y_2O_3, CaO, MgO, BeO, TiB_2, TiC, HfC, and ZrC. On the basis of purely thermodynamic arguments, upper temperature limits are suggested for each material for long-term use in H_2-containing atmospheres.

28494 (ORNL/FTR–3597) **[Collaboration for improved understanding of implanted ceramics]: Foreign trip report, March 15, 1990–March 25, 1990.** McHargue, C.J. Oak Ridge National Lab., TN (USA). 9 Apr 1990. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009395. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The visit to the University Claude Bernard was to analyze data obtained there and at ORNL in a collaborative research program, to exchange samples, to plan further work, and to prepare drafts of

two manuscripts for publication. The traveler also attended a meeting of the organizers of a NATO-ASI entitled "Diamond and Diamond-Like Films and Coatings" that will be held in Italy in July–August 1990. The purpose of this organizing meeting was to establish the program and other organization details.

28495 (PB–90-163981/XAB) **Institute for Materials Science and Engineering, Ceramics: Technical activities 1989.** Hsu, S.M. National Inst. of Standards and Technology (IMSE), Gaithersburg, MD (USA). Ceramics Div. Dec 1989. 156p. (NISTIR–89/4148). Available from NTIS, PC A08/MF A01.

See also report for 1988, PB–89-148381.

The primary impediments to the growth of the advanced ceramics industry are lack of reliability and high cost of ceramic components and devices. Fine powders from which advanced ceramics are made are crucial in determining the cost and final properties of a product. For this reason, the Division has developed a strong capability in the synthesis, characterization and processing of powders. Improvements in the reliability of advanced ceramics, whether for structural or functional applications, require a mechanistic understanding of the modes of failure to which a ceramic is susceptible. To further the impact in this area the Division has focused their efforts on the understanding of microstructural features which control brittle fracture and high temperature creep. Efforts in the functional ceramic field have included, for electronic applications, the continuation of processing-property studies on piezoelectric materials as well as a major effort on high T_c superconducting ceramics. The microstructural features which limit the application of high temperature superconductors have been addressed as part of the NIST superconductivity initiative. Research in the optical materials area has included the development of techniques of deposition and analysis of diamond films which are expected to find application as protective coatings on a variety of detector windows.

28496 (SAND–89-0183C) **Surface structure and chemistry of high surface area silica gels.** Brinker, C.J. (Sandia National Labs., Albuquerque, NM (USA)); Brow, R.K.; Tallant, D.R.; Kirkpatrick, R.J. Sandia National Labs., Albuquerque, NM (USA). [1989]. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-8906295–1: 10. university conference on glass science, State College, PA (USA), Jun 1989). Order Number DE90007684. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Combined Raman and ^{29}Si NMR investigations of high surface area silica gels indicate that dehydroxylation of the a-SiO_2 surface results preferentially in the formation of cyclic trisiloxanes (3-membered rings). Estimates of the maximum experimentally observed concentration of 3-membered rings correspond to a surface coverage of about 28-58%. Two consequences of 3-membered rings on the a-SiO_2 surface are enhanced hydrolysis rates and increased skeletal densities. 29 refs., 6 figs.

28497 Application of electron microscopy for the analysis of the mechanical behavior of advanced ceramics. Tennery, V.J. (Oak Ridge National Lab., TN (USA)); Allard, L.F.; Nolan, T.A.; Rawlins, M.H. 8p. American Society of Mechanical Engineers, New York, NY (USA) (1988). (CONF-880607–: 33. ASME international gas turbine and aeroengine congress and exposition, Amsterdam (Netherlands), 5-8 Jun 1988).

88-GT-72.

The authors discuss the microstructure and fracture surfaces of two commercially available silicon nitride ceramics characterized using techniques of scanning and analytical transmission electron microscopy. These results have been correlated to mechanical property data (obtained from static and dynamic fatigue tests using four-point flexural test methods both at room temperature and at elevated temperature). For one of the materials, the results clarified failure mechanisms. For the other, the results showed how processing variables can affect microstructure (and thus mechanical behavior), and emphasized particularly that mechanical tests of billet-derived specimens may be unreliable in predicting the mechanical behavior of production components.

28498 Interfacial structure, properties and design. Materials Research Society symposium proceedings. Volume 122. Yoo, M.H. (Oak Ridge National Lab., TN (USA)); Clark, W.A.T.; Briant, C.L. 609p. Materials Research Society, Pittsburgh, PA (USA) (1988). Grant DMR8720419. (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

These proceedings are organized in the order of presentation at the meeting, starting with the recent advances in structural characterization and analysis of internal interface and interphase boundaries. While the crystallographic theory of interfacial line defects had been established rigorously, its general applicability to mixed tilt and twist boundaries was questioned. The insights obtained from theoretical and experimental analyses of elasticity and localized deformation at interfaces relate directly to the intrinsic cohesive strength and intergranular fracture. Effects of processing on the grain boundary structure and chemistry of high T_c ceramic superconductors and the resulting changes in critical currents were established experimentally. A significant advancement was reported in processing and crystal growth techniques, which include the UHV diffusion bonding and MBE techniques for the controlled production of homo- and heterophase interfaces.

28499 Atomic structure of tilt grain boundaries in NiO. Merkle, K.L. (Materials Science Div.); Smith, D.J. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract W-31-109-ENG-38. (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

High resolution electron microscopy at 400 kV has been used to study the core structure of large-angle ⟨001⟩ tilt grain boundaries in NiO. The deduced atomic structures show considerable variety and complexity, even for boundaries with the same tilt axis and misorientation. The coexistence of asymmetric and symmetric boundaries which is observed at each misorientation suggests that asymmetric grain boundaries containing densely packed planes are associated with relatively low free energies. A multiplicity of core structures is found for the $\Sigma = 5$ and the $\Sigma = 13$ grain boundaries. The normal component of the rigid-body translation in these boundaries is quite small in view of the relatively open structure that is expected for grain boundaries in ionic solids. Substantial concentrations of Schottky pairs near the boundary cores, as well as relaxations parallel to the misorientation axis, are indicated.

28500 Modeling ore reduction in thermal plasmas. Varacalle, D.J. (Idaho National Engineering Lab., Idaho Falls, ID (USA)). pp. 60 of Proceedings of the 1987 Pacific Northwest metals and minerals conference (abstracts): Modern mineral and metal technology. Albany Research Center, Albany, OR (USA) (1987). (CONF-8704166–: Pacific Northwest metals and minerals conference, Portland, OR (USA), 26-28 Apr 1987).

Thermal plasmas produced with dc nontransferred arc torches have been receiving increased attention for materials processing applications. It is advantageous to analytically characterize these plasma systems to determine the most optimum conditions to achieve the desired chemical products. Several analytical models are available for analyzing the behavior of thermal plasmas and the thermochemistry of injected species in the free plume of these torches. Numerical prediction of the flow, temperature, and concentration fields of a high intensity, atmospheric pressure, free-length argon arc with particle injection (A1 $_2$ 0 $_3$ /C) are presented. The plasma physics solutions show a high temperature, high velocity (11500 K, 200 m/s) region adjacent to the cathode a the centerline which decays to moderate (1100 K, 15 m/s) conditions at 0.25 m into the plume. The trajectories of 5 lnm A1 $_2$ 0 $_3$ and C particles are approximated. Both equilibrium and kinetic thermochemistry calculations indicate the feasibility of the carbothermic reduction of alumina at high temperature.

28501 Anion grain boundary diffusion in Cr_2O_3 and Cr_2O_3-0.09 weight percent Y_2O_3. King, W.E. (Chemistry and Materials Science Dept., Lawrence Livermore Lab., Livermore, CA (USA)); Park, J.H. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract W-31-109-ENG-38. (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

Anion diffusivities in the lattice and along grain boundaries have been measured on sintered polycrystals of Cr_2O_3 and Cr_2O_3-0.09

weight percent Y_2O_3 at 1100°C and at the oxygen partial pressure corresponding to that of the Cr/Cr_2O_3 equilibrium at that temperature. Results show that under the same conditions, anion diffusion is significantly faster than caution diffusion. The results are discussed in terms of their implications for the reactive element effect on high temperature oxidation of chromia forming alloys.

28502 COmparison of the thermal stabilities of amorphous hydrides formed by Zr-based metallic glasses. Cantrell, J.S. (Miami Univ., Oxford, OH (USA). Dept. of Chemistry); Bowman, R.C. pp. 462 of Science and technology of rapidly quenched alloys. Tenhover, M.; Johnson, W.L.; Tanner, L.E. Materials Research Society, Pittsburgh, PA (USA) (1987). (CONF-861207–: Materials Research Society fall meeting, Boston, MA (USA), 1-5 Dec 1986).

The authors report differential scanning calorimetry (DSC) and x-ray diffraction (XRD) measurements performed on a-Zr_2 PdH_x and a-Zr_2NiH_x to assess the effects of hydrogen on their thermal stabilities. Only exothermic DSC peaks were observed for the hydrogen-free glasses and are shown to correspond to the formation of crystalline intermetallic phases. On the other hand, heating of the amorphous hydrides gives decomposition reactions with the generation of ZrH_x ($1.5 < x < 2.0$) and either free metal (e.g. Rh) or a Zr-depleted intermetallic (e.g, ZrPd). With the exception of the Zr_2 PdH_x samples, hydrogenation significantly decreases the thermal stabilities (i.e., the exothermic transitions occur at lower temperatures in the amorphous hydrides). Endothermic peaks, which are associated with hydrogen evolution from the glass, are observed when the hydrogen-to-metal ratios approach unity.

28503 MoS_2 interactions with 1.5 eV atomic oxygen. Martin, J.A. (Los Alamos National Lab., Los Alamos, NM (USA)); Cross, J.B.; Pope, L.E. pp. 524 of New materials approaches to tribology: Theory and applications. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC04-76DP00789. (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

Exposures of MoS_2 to 1.5 eV atomic oxygen in an anhydrous environment reveal that the degree of oxidation is essentially independent of crystallite orientation and the surface adsorbed reaction products are MoO_3 and MoO_2. A mixture of oxides and sulfide exist over a depth of about 90 Å and this layer has a low diffusion rate for oxygen. It is concluded that a protective oxide layer will form on MoS_2 upon exposure to the atomic-oxygen-rich environment of low earth orbit.

28504 The adherence of nickel oxide on nickel during high-temperature oxidation. Liu, Y.Y. (Argonne National Lab., IL (USA). Materials Science and Technology Div.); Natesan, K. pp. 2 of Adhesion in solids. Mattox, D.M.; Baglin, J.E.E.; Gottschall, R.J.; Batich, C.D. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract W-31-109-ENG-38. (CONF-8804117–: Adhesion in solids, Reno, NV (USA), 5-7 Apr 1988).

A combined experimental/analytical study is being conducted to investigate the fundamental nature of adherence of oxide scales formed on metals during high-temperature oxidation. Isothermal oxidation experiments were conducted on high-purity nickel (Ni 270) specimens in air at temperatures of up to 1200°C. None of the experiments resulted in physical separation of nickel oxide scales from the nickel substrate, even though substantial amounts of porosity were found in scales close to the scale/metal interfaces. The results of numerical and analytical calculation of stresses in the NiO/Ni system suggest that metal and oxide plasticities play a role in the experimental observations.

28505 Microstructure and wear characterization of self-lubricating Al_2O_3 - MoS_2 composite ceramic coatings. Koshkarian, K.A. (Dept. of Materials Science and Engineering and Materials Research Lab., Univ. of Illinois at Urbana-Champaign, Urbana, IL (USA)); Kriven, W.M. pp. 524 of New materials approaches to tribology: Theory and applications. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC02-76ER01198. (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

The authors report the results of composite ceramic coatings of alumina Al_2O_3 containing some molybdenum disulfide MoS_2 electro-codeposited on to Al metal substrates by a combination of anodic sparks deposition of Al_2O_3 and electrophoresis of MoS_2. The microstructures were characterized by XRD, XPS, SEM, EDS, SNMS, TEM, SAD and relative wear resistance measurements. The coatings consisted mostly of Al_2O_3 with some and present as well. The coatings were porous and microcracked. SEM showed them to consist of circular splats which had rapidly crystallized from the molten state in areas of dielectric breakdown in the coating. In the TEM the microstructure was seen to contain sets of parallel, elongated grains having a single crystallographic orientation. The grains were separated by dislocated, low angle grain boundaries or microcracks. The sets intersected at irregularly curved interfaces and were mechanically interlocked. Quantitative SNMS indicated that up to 26 wt% MoS_2 was incorporated in coatings fabricated from 5g/1 solutions. SEM/EDS as well as TEM/SAD/EDS identified 1-3 μ particles of MoS_2 incorporated into the 5g/1 solution derived coatings. These coatings exhibited 50% lower wear rate than pure alumina coatings deposited under the same condition.

28506 Application of controlled pore structures to kinetic studies in alumina. Rodel, J. (Dept. of Materials Science and Mineral Engineering, Lawrence Berkeley Lab., Univ. of California, Berkeley, CA (USA)); Glaeser, A.M. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract AC03-76SF00098. (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

The application of controlled-geometry interfacial pore structures to fundamental kinetic studies in alumina is described. Results from studies of the morphological stability of high aspect pore channels, crack healing, pore coarsening and pore elimination in sapphire are presented.

28507 Effects of small deviations from stoichiometry on grain boundary compositions in $YBa_2Cu_3O_{7-x}$. Kroeger, D.M. (Metals and Ceramics Div., Oak Ridge National Lab., Oak Ridge, TN (USA)); Brynestad, J.; Williams, R.K.; Padgett, R.A.; Scarbough, J.O. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract AC05-84OR21400. (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

Comparison of Auger electron spectra for intergranular and transgranular areas on fracture surface of sintered $YB_2Cu_3O_{7-x}$ indicates the presence of a grain-boundary layer which is copper-rich and oxygen-poor compared to the bulk. This layer is believed to be an important factor limiting the critical current density in sintered material. The composition of the grain-boundary layer is strongly affected by small changes in sample composition, as might be expected for a line compound. These small deviations from the stoichiometric composition also affect the critical current density and the electrical resistivity above the transition temperature.

28508 Magnetic phase diagram of La_2CuO_4. Crabtree, G.W. (Argonne National Lab, Argonne, IL (US)); Welp, U.; Kwok, W.K.; Vandervoort, K.G.; Liu, J.Z.; Umezawa, A. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-31-109-ENG-38. Contract STC-8809854. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The magnetic phase diagram of La_2CuO_4 is determined from dc magnetization measurements for the field parallel and perpendicular to the plane of the layers. No phase transition between weak ferromagnetism and paramagnetism is found.

28509 The identification of oxygen related species in the XPS and near edge spectra of the high T_c superconductors. Lin, C.L. (Brookhaven National Lab, Upton, NY (US)); Qiu, S.L.; Chen, J.; Tranquada, J.M.; Strongin, M.; Crow, J.E.; Chu, C.W. pp. 1744 of Proceedings of the international conference on materials

and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract AC02-76CH00016. Grant DMR8802401. (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors describe data on various oxygen-metal species. They also present near edge data on electron doped superconductors.

28510 Angle-resolved photoemission study of NIO and CoO. Shen, Z.X. (Stanford Electronics Lab, Stanford Univ., Stanford, CA (US)); Lindberg, P.A.P.; Shih, C.K.; Spicer, W.E., Lindau, I. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). Contract AFOSR-87-0398. (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors report an angle-resolved photoemission investigation of the electronic structures of NiO and CoO. The lattice effects on the photoemission spectra of these highly correlated materials are important. The magnitudes of dispersions of the oxygen bands agree with band calculations, but the experimental data of the localized 3d bands do not agree with the band calculations.

28511 Evidence for phonon-mediated coupling in superconducting $Ba_{1-x}K_xBiO_3$. Hinks, D.G. (Materials Science Div., Argonne, IL (US)); Dabrowski, B.; Richards, D.R. Jorgensen, J.D.; Pei, S.; Zasadzinski, J.F. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

Superconducting $Ba_{1-x}K_xBiO_3$, with a T_c of 30 K, shows a large ^{18}O isotope effect which indicates that phonons are involved in the pairing mechanism. Superconducting energy gap measurements from IR reflectivity and tunneling are consistent with moderate coupling ($2(cgd)/kT_c = 3.5 \pm 0.5$). A characteristic phonon energy of about 40 meV would be required to obtain the high T_c. Neutron scattering measurements show a large density of phonons in the range 40 to 80 meV and strong coupling of electrons to these modes is indicated in tunneling spectroscopy. Additional results are reported, including the structural phase diagram, which suggest that superconductivity is phonon mediated.

28512 T*-phase superconductivity. Fisk, Z. (Los Alamos National Lab, Los Alamos, NM (US)); Cheong, S.W.; Thompson, J.D.; Hundley, M.F.; Schwarz, R.B.; Kwei, G.H.; Schirber, J.E. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE contract AC04-76PP00789. (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The T*-phase is a mixed rare earth oxide phase forming at the composition R_2CuO_4. Its crystal structure is intermediate between the La_2CuO_4 and Nd_2CuO4 structures. Sr-doped samples have T_c onsets as high as 37 K. The authors discuss the systematics of T_c of T* -phases as a function of Sr doping, rare earth mixture and oxygenation. Structural and transport data are also presented.

28513 Magnetization of grain-aligned $HoBa_2Cu_3O_7 - \delta$. Wacenousky, M. (Atominstitut der Osterreichischen Univ., A-1020 Wien (AT)); Weber, H.W.; Hyun, O.B.; Finnemore, D.K. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper reports cylinders of grain-aligned $HoBa_2Cu_3O_{7-\delta}$ superconductors in epoxy investigated using differential magnetization and ac susceptibility techniques int he temperature range 2 K (lte) T (lte) T_c. From both experimental techniques, demagnetizing factors of the grains could be deduced for H(double fence rule)c and for H(double fence rule)a,b, which compare reasonably well with estimates based on the size and shape of the grains. With this information, absolute values of the lower critical field H_{c1} (first flux penetration field), its anisotropy and temperature dependence were obtained. Furthermore, magnetization critical current densities (intragrain j_c's) were calculated from the magnetization curves as well as from minor hysteresis loops. Pronounced anisotropies of j_c as well as significant contributions of the Ho-moments to the magnetization, in particular in the (a,b)-plane, have been observed.

28514 Elastic softening and internal friction in $La_{2-x}Sr_xCuO_4$. Lee, W. (Henry Krumb School of Mines, Columbia University, New York, New York 10027 (US)); Lew, M.; Nowick, A.S. *Physical Review, B: Condensed Matter (USA),* 41(1): 149-154 (1 Jan 1990). DOE Contract FG02-88ER45341.

The Young's modulus *E* and the internal friction of polycrystalline ceramic $La_{2-x}Sr_xCuO_4$ were measured over the composition range $0.05 \leq x \leq 0.30$. A striking elastic constant anomaly, reported previously, was observed, in which *E* falls by 40% or more and the internal friction increases with decreasing temperature. The temperature region of the elastic softening falls rapidly with increasing Sr concentration *x* and occurs near the tetragonal-orthorhombic (*T-O*) transition temperature. The "soft" modulus does not recover at lower temperatures but persists to at least ~100 K. This elastic softening and the accompanying internal friction are attributed to stress-induced migration of martensitic domain boundaries produced by the *T-O* transition. It is also found that there is no correlation between the elastic softening and the occurrence of superconductivity.

28515 Specific heat in a magnetic field: A probe of the magnetic ground-state properties of heavy-fermion $Ce(Ru_{2-x}Rh_x)Si_{2-y}Ge_y$. Kim, J.S. (Department of Physics, University of Florida, Gainesville, Florida 32611 (US)); Andraka, B.; Fraunberger, G.; Stewart, G.R. *Physical Review, B: Condensed Matter (USA),* 41(1): 541-546 (1 Jan 1990). DOE Contract FG05-86ER45268.

Specific-heat data up to 12.5 T are presented for $CeRu_2Si_2$, $Ce(Ru_{0.5}Rh_{0.5})_2Si_2$, and $CeRu_2Si_{1.8}Ge_{0.2}$. The behaviors with field of the specific heats are compared, also with susceptibility data. The possibility that the maximum in *C/T*, or γ, at $H_{metamagnetic}$=8 T in $CeRu_2Si_2$ corresponds to an increase in m^* at the metamagnetic transition is discussed. Similar data for CeB_6 are compared.

28516 Helium release from aged palladium tritide. Abell, G.C. (EG&G Mound Applied Technologies, Post Office Box 3000, Miamisburg, Ohio 45343-0987 (USA)); Matson, L.K.; Steinmeyer, R.H.; Bowman, R.C. Jr.; Oliver, B.M. *Physical Review, B: Condensed Matter (USA),* 41(2): 1220-1223 (15 Jan 1990). DOE Contract AC04-88DP43495.

Experimental studies of helium release from aged PdT_x show that the helium-to-metal-atom ratio saturates at a value of [He]/[Pd]≅0.5 under conditions of ambient-temperature storage. Below this value, very little helium release occurs. Thermal desorption experiments show that release from a sample with [He]/[Pd]≅0.3 requires temperatures in excess of ~600 K, while release from a sample with [He]/[Pd]≅0.02 requires temperatures in excess of at least 1300 K. These results are related to the question of the disposition of helium that would be produced by hypothetical fusion reactions in a PdD_x electrode.

28517 60-Hz ac losses in $YBa_2Cu_3O_7$ cylinders. Orehotsky, J. (Department of Applied Science, Brookhaven National Laboratory, Upton, New York 11973 (US)); Garber, M.; Xu, Y.; Wang, Y.L.; Suenaga, M. *Journal of Applied Physics (USA),* 67(3): 1433-1436 (1 Feb 1990). DOE Contract AC02-76CH00016.

60-Hz ac losses at 4.2 and 77 K for sintered $YBa_2Cu_3O_7$ cylinders having a large difference in the grain size were measured as a function of applied magnetic field. The results are discussed in terms of the intra- and transgranular critical current densities in the specimens.

28518 Stages in the evolution of colloidal chromium(III) oxide. Swayambunathan, V. (Argonne National Lab., IL (USA)); Liao, Y.X.; Meisel, D. *Langmuir (USA),* 5(6): 1423-1427 (Nov-Dec 1989). DOE Contract W-31-109-ENG-38.

Three crystalline stages in the evolution of chromium(III) oxide particles were identified by transmission electron microscopy and electron diffraction. Equinormal solutions of chromium(III) salt and potassium hydroxide were found to contain crystalline $Cr(OH)_3 \times 3H_2O$ particles of irregular morphologies after a long aging period at room temperature. When dispersions of this hydroxide are subjected to heating at 100°C, larger monodispersed particles of a previously unknown intermediate species were obtained. This crystalline intermediate is proposed to be an oxyhydroxide of the composition $CrO_{(3-x)/2}(OH)_x$. Further heating of the solution leads to further growth and phase transformation of the intermediate species into crystalline Cr_2O_3 particles of a narrow size distribution.

28519 Oxidation of metastable single-phase polycrystalline $Ti_{0.5}Al_{0.5}N$ films: Kinetics and mechanisms. McIntyre, D. (Department of Materials Science, Coordinated Science Laboratory and the Materials Research Laboratory, University of Illinois, 1101 West Springfield Avenue, Urbana, Illinois 61801 (USA)); Greene, J.E.; Hakansson, G.; Sundgren, J.; Muenz, W. *Journal of Applied Physics (USA),* 67(3): 1542-1553 (1 Feb 1990). DOE Contract AC02-76ER01198.

Metastable single-phase, NaCl-structure, polycrystalline $Ti_{0.5}Al_{0.5}N$ alloy films have been shown to exhibit much better high-temperature (750–900 °C) oxidation resistance than polycrystalline TiN films grown under similar conditions. The $Ti_{0.5}Al_{0.5}N$ alloys, ≅3 μm thick, were deposited at temperatures between 400 and 500 °C on stainless-steel substrates by dc magnetron sputter deposition in mixed $Ar+N_2$ discharges with an applied negative substrate bias V_s of either 0 or 150 V. Oxidation in pure O_2 initially occurred at a rate that varied parabolically with time. The oxide overlayers consisted of two partially crystalline sublayers, the upper one Al-rich and the lower one Ti-rich, with no measurable N concentrations in either. Inert-marker transport experiments showed that oxidation proceeded by the simultaneous outward diffusion of Al to the oxide/vapor interface and inward diffusion of O to the oxide/nitride interface. The oxidation rate constant K increased with oxidation temperature T_{ox} at a rate much higher than would be predicted from a simple exponential dependence due to changes in the oxide microstructure (increased crystallinity) with increasing T_{ox}. At $T_{ox} \geq 850$ °C, O transport became the rate-limiting step. After oxidation times, ranging from 6 h at 750 °C to 7 min at 900 °C, oxide crystallites, exhibiting a tetragonal rutile TiO_2 structure, were observed in V_s=0 samples to grow at an accelerated rate up through cracks in the oxide overlayer. The formation of these crystallites was postponed until a much later stage in oxide-overlayer development for samples grown with V_s=150 V.

28520 Electron and proton radiation effects in the high temperature superconductor $YBa_2Cu_3O_7$- δ. Summers, G.P. (Naval Research Lab., Washington, DC (US)); Chrisey, D.B.; Maisch, W.G.; Strauss, G.H.; Burke, E.A.; Nastasi, M.; Tesmer, J.R. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 36(6): 1840-1847 (Dec 1989). (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

The particle-induced depression of the superconducting critical temperature, T_c, of $YBa_2Cu_3O_{7-\delta}$ is shown to be directly proportional to the nonionizing energy loss (NIEL) of primary knock-on atoms (PKAs) displaced by incident electrons, protons, and heavy ions, which cover a NIEL range of over seven orders of magnitude. Calculations of the NIEL for electrons and protons are given for $YBa_2Cu_3O_7$ over the range 1-1000 MeV. The partition of NIEL among the element as a function of incident electron energy is discussed. For a given particle fluence Φ, it is concluded that $dT_c/d\Phi$ is proportional to the average number of defects produced, is not affected by the formation of defects in cascades, and is independent of the PKA spectrum. This means that the particle-induced depression of T_c can be predicted for any particle type, for any energy, and for any fluence.

28521 Internal structure of porous silica: A model system for characterization by nuclear magnetic resonance. Bhattacharja, S. (Dept. of Physics and Astronomy, Northwestern Univ., Evanston, IL (US)); D'Orazio, F.; Tarezon, J.C.; Halperin, W.P. *Journal of the American Ceramic Society (USA),* 72(11): 2126-2130 (Nov 1989). Program DMR85-20280.

Nuclear magnetic resonance (NMR) relaxation methods have been used to investigate the internal structure of porous silica gelled from colloidal silica and potassium silicate mixtures. These materials possess a narrow pore size distribution with average pore diameter ranging from 470 to 2400 Å (47 to 240 nm) as determined from mercury intrusion porosimetry. NMR relaxation measurements were performed on deionized water impregnated into the pore space. These results determine the distribution of local surface-to-volume ratios and show that all of the silica samples are very uniform on a length scale greater than 5 μm. NMR relaxation measurements performed on silica samples partially filled with water provide a precise confirmation of the theoretical model upon which the NMR pore structure analysis is based. Measurements of the relaxation strength at the water-silica interface were found to depend systematically on the initial composition of the material. The self-diffusion coefficient of water, saturated in the pore space, is reduced by 14% from its bulk value.

28522 The determination of the free energy of formation of binary tellurides using lithium coulometric titration techniques. Fleming, J.G. (Sandia National Labs., Albuquerque, NM (US)); Stevenson, D.A. *Journal of the Electrochemical Society (USA),* 136(12): 3859-3862 (Dec 1989).

The authors report low-temperature electrochemical coulometric titration technique using Li developed and used to determine the Gibbs free energies of formation of binary telluride compounds. The approach is based on the metal/lithium/tellurium phase diagram and relies upon the rapid diffusion of Li in these systems. The Gibbs free energy of formation of Li_2Te was determined by electrochemically titrating Li into pure Te until a two-phase Li_2Te/Te mixture was formed. A value of -82.1 plus or minus 0.3 kcal/mol was calculated. With this information, the Gibbs free energies of formation of HgTe, CdTe, and ZnTe were determined from the measured Li electrochemical potential found in appropriate metal/telluride/Li_2Te Gibbs tie triangle regions. ZnTe and CdTe and were investigated by depositing a large amount of Li on the sample in question and observing a constant potential region after ion annealing times. HgTe and $Hg_{0.8}Te_{0.2}$ were investigated by depositing a small amount of Li on the sample and observing the short time transient, with no plateau observed, but a characteristic kink potential. Suitable analysis of the potential-time response characteristics for these cases lead to values for the free energies of formation of CdTe and ZnTe and HgTe of – 23.2 ± 0.6 and – 26.4 ± 0.9 kcal/mol and – 6.8 ± 111 kcal/mol, respectively, in good agreement with the information in the literature.

3606 Other Materials

Refer also to citation(s) 27444, 27452, 27684, 27701, 27721, 27723, 27724, 27725, 27967, 28097, 28252, 28388, 28393, 28413, 28459, 28462, 28502, 28617, 28650, 28655, 28695, 28708, 28710, 28730, 28751, 28761, 28763, 28840, 28842, 28921, 28925, 28927, 28936, 28986, 29105, 29269, 29277, 29356, 29357, 29585

28523 (AD-A–216527/2/XAB) **Interfacial chemistry of MoS_2 films on Si. Annual technical report.** Bertrand, P.A. Aerospace Corp., El Segundo, CA (USA). Chemistry and Physics Lab. 10 Nov 1989. 31p. (ATR–89(4752)-3). Available from NTIS, PC A03/MF A01.

The adhesion of thin films to their substrates is an important factor in their use in electronics, corrosion prevention, and lubrication. In particular, adhesion may be the critical parameter that determines the wear life of solid lubricant films; it has been suggested

that films fail when they are pushed out of the wear track. Systems with chemical bonds across the interface will have enhanced adhesion over systems in which only van der Waals interactions are operative. Covalent materials, such as the important engineering ceramics SiC and Si3N4 and the solid lubricant MoS2, have strong directional bonds. If the same kind of bonds could be formed between such materials, a strongly adhesive lubricant-substrate system should result. The interface between rf-sputter-deposited MoS2 films and single-crystal Si was studied by observing thin (<100 A) films with electron energy loss spectroscopy, Auger electron spectroscopy, and x-ray photoelectron spectroscopy. The interface is not atomically smooth; it is a broad and chemically complex region. The surface of the native oxide (SiO2) is sulfated by the plasma. The initial MoS2 in films deposited at 220 C is chemically the same as crystalline MoS2; that is, there is no chemical bonding between the film and the substrate. There is evidence that the initial MoS2 in films deposited at 70 C is chemically bonded to the crystal, perhaps through Mo-S-O or Mo-O linkages.

28524 (AD-A-216530/6/XAB) **Materials processing of diamond: Etching, doping by ion implantation, and contact formation. Annual technical report, 1 October 1988-30 September 1989.** Swanson, M.L. North Carolina Univ., Chapel Hill, NC (USA). Dept. of Physics and Astronomy. 30 Sep 1989. 46p. Available from NTIS, PC A03/MF A01.

We are studying implantation doping, etching, contact formation, and regrowth of natural diamond, for future applications to the fabrication of devices from thin film CVD diamond. In addition, we are characterizing thin film diamonds of other ONR contractors, using iron beam methods. In diamond, implantation doping is difficult because the high annealing temperature necessary to remove damage and to obtain efficient dopant activation often causes graphitization. We have used an innovative co-implantation of C plus the desired dopant at 77 K, followed by rapid thermal annealing (RTA) or furnace annealing, to overcome this problem. The removal of surface layers of diamond by polishing or chemical etching is hampered by its extreme hardness and chemical inertness. We have demonstrated that reactive ion etching with O is an effective method of removing controlled amounts of diamond. We have developed a new sputtering method of forming strong metallic contacts to diamond at ambient temperatures, which may prove invaluable for microelectronics and heat sink applications. Factors affecting epitaxial regrowth of damaged natural diamond are crucial for both ion beam doping and CVD growth. We have successfully regrown C-ion implanted natural diamond layers by RTA or furnace anneals.

28525 (AD-A-216540/5/XAB) **Spallation and dynamic fracture as an effect of laser-induced shock waves in carbon based composite materials. Final technical report.** Eliezer, S.; Gilath, I. Center for Nuclear Research, Soreq (Israel). Oct 1989. 47p. Available from NTIS, PC A03/MF A01.

A high irradiance single beam short pulsed Nd:glass laser was used to generate shock waves in carbon-carbon and carbon epoxy composites. Dynamic brittle fracture at hypervelocity impact conditions was observed as a result of reflected shock waves as tensile waves from the back surface of samples. Successive stages of damage from incipient spallation to complete sample perforation were obtained by increasing gradually the laser energy. The thermo mechanical damage on the front surface as a result of laser interaction with the target material, and the mechanical damage at the back surface as a result of shock wave reflection were characterized by optical and scanning electron microscopy. The failure properties of the carbon composites were related to the processing of densification and graphitization mode. While the failure properties for carbon epoxy composites were related to impact direction versus fiber direction. A comparison was made between spall properties fo carbon epoxy composites with aluminum and iron. A new experimental method was developed to calculate the attenuation of laser generated shock waves. This technique enables also the evaluation of the laser induced spall pressure in different materials.

28526 (AD-A-216764/1/XAB) **Instrumented impact testing of fabric-reinforced composite materials. Research and development report.** Juska, T.D.; Crane, R.M.; Mixon, T. David Taylor Research Center, Bethesda, MD (USA). Ship Materials Engineering Dept. May 1989. 43p. (DTRC/SME-89-20). Available from NTIS, PC A03/MF A01.

Instrumented impact and ultrasonic inspection were used to assess the impact damage resistance of six fabric-reinforced laminates. Polyester and vinylester resins reinforced with woven roving, biaxial reinforcement, and glass/Kevlar hybrid were evaluated. Biaxial fabric reinforced resins had the best impact resistance. This determination is based on the ability of these materials to survive impact with the lowest friction of impact energy resulting in damage. In addition laminates with biaxial reinforcement ahd comparable damage areas to the other materials.

28527 (AEEW-R-2414) **Theoretical calculations of primary particle condensation for cadmium and caesium iodide vapours.** Bowsher, B.R. (UKAEA Atomic Energy Establishment, Winfrith (United Kingdom)); Buckle, E.R. UKAEA Atomic Energy Establishment, Winfrith (UK). Chemistry Div. Oct 1988. 40p. Order Number DE90624420. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This report considers a model of aerosol nucleation from the vapour phase which has been developed by Buckle. The applicability of the model has been tested by considering the condensation of caesium iodide and cadmium vapours under a wide variety of pre-mixed flow conditions of interest to PWR severe accident studies. (U.K.).

28528 (AEEW-R-2544) **An assessment of glass microspheres for use as number-based aerodynamic size standards.** Ball, M.H.E. (UKAEA Atomic Energy Establishment, Winfrith (United Kingdom)); Marshall, I.A.; Mitchell, J.P.; Rideal, G. UKAEA Atomic Energy Establishment, Winfrith (UK). Chemistry Div. Aug 1989. 23p. Order Number DE90624421. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Polydisperse, non-porous microspheres are required with well-defined aerodynamic properties to determine if enhanced settling of micron-sized aerosol particles occurs in the presence of larger particles (gravitational agglomeration). Glass spheres with claimed unimodal narrow distributions were evaluated using a TSI Aerodynamic Particle Sizer (APS33B). The size fractions containing particles in the range from 1 to 5 μm aerodynamic diameter were truly unimodal, but the fractions which were supposed to consist solely of particles larger than 5 μm aerodynamic diameter contained a significant proportion of submicron particles. (author).

28529 (AGARD-R-771, pp. 9) **Improved performance polysulfide based sealant.** Sharaby, A. Products Research and Chemical Corp., Glendale, CA (USA). Nov 1989. (CONF-8904341--: Fuel tank technology conference, Ontario (Canada), 23 Apr 1989). In *Fuel Tank Technology*. Available from NTIS, PC A08/MF A01; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive.

It was recently discovered that low viscosity mercaptan terminated polymers which exhibit application and performance properties superior to their precursor materials can be obtained by chemical modification of Thiokol LP polymers. For example, these chemically modified Thiokol LP polymers, known as Permapol P-5 polymers, can be formulated and cured using similar methods as LP polymers to give elastomeric materials which, compared to the same LP polymer based materials, exhibit: superior ozone and UV radiation resistance; higher physical properties; better fuel resistance; higher temperature resistance; greater compatibility with traditional plasticizers; better adhesion to many substrates after exposure to liquids such as aromatic hydrocarbon containing fuels; and better resistance to permeability of inert gases and fuel vapors. The properties and uses, of this new class of polymers, in some sealant formulations are described as compared to their precursor materials, the Thiokol LP polymer.

28530 (BFR-R-69-1989) **Sandwich panels of expanded urethane plastic: Influence of surface layer ageing on the heat resistance.** Isberg, J. (Chalmers tekniska hoegskola, Goeteborg (SE). Avd. foer husbyggnad). Swedish Council for Building Research, Stockholm (Sweden). 1989. 100p. (In Swedish). Project BFR-870544-3. Order Number DE90770873. Available from NTIS (US Sales Only), PC A05/MF A01.

The heat resistance of 11 years old wall panels insulated by expanded urethane plastic was measured. The object was to find out if normal building panels prevent ageing of the plastic. The measurements show that the panels have the same heat resistance today as when manufactured. Despite of this fact any genral conclusion that the panel sheets prevented air to penetrate the plastic foam cannot be drawn. A closer analysis of the core of one of the panels revealed that the heat resistance of that part is not in agreenment with the properties of a newly fabricated material. The report also presents measurements of urethane panels with a 25 μm Al-foil. This foil did not prevent the ageing process. Experiments with samples with and without 'casting' skin show that the latter could have an effect on air penetration and thus on the change of conductivity with time.

28531 (CONF-900419–4) **A study of the formation and self-lubrication mechanisms of boric acid films on boric oxide coatings.** Erdemir, A.; Fenske, G.R.; Erck, R.A. Argonne National Lab., IL (USA). [1990]. 19p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 8. international triennial conference on thin films and the 17th international conference on metallurgical coatings; San Diego, CA (USA); 1-6 Apr 1990. Order Number DE90010115. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An investigation was made of the formation and self-lubrication mechanisms of boric acid films on boric oxide coatings prepared by vacuum evaporation. Measured friction coefficients of a steel ball sliding on a boric-oxide-coated-steel disk and a sapphire ball sliding on a boric-oxide-coated-alumina disk were 0.025 to 0.05 at steady state, depending on load and substrate material. This low friction was correlated with the formation of a lubricious boric acid film on boric oxide coatings exposed to open air. For the mechanism of self-lubrication, the layered-triclinic-crystal structure of boric acid was proposed. The atoms constituting each boric acid molecule are arrayed in closely packed and strongly bonded layers that are 0.318 nm apart and held together by weak forces, such as van der Waals. It is hypothesized that during sliding, these layers can align themselves parallel to the direction of relative motion, and once so aligned,, can slide over one another with relative ease to provide low friction. Structural and chemical findings were included to substantiate the proposed solid lubrication mechanism. 15 refs., 5 figs.

28532 (CONF-900466–7) **Microstructure and mechanical properties of Ni_3Al–Al_2O_3 composites produced by hot extrusion.** McKamey, C.G.; Lee, E.H. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90009856. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Hot extrusion of premixed charges of 10–20 vol% chopped Al_2O_3 fiber and Ni_3Al powder has resulted in composite alloys of near theoretical density. In tensile tests at room temperature, density-compensated yield strengths of some of these composite alloys are as good or better than those of as-cast or hot-pressed Ni_3Al without reinforcement; however strengths at 1000°C in vacuum are lower. The low strength at 1000°C is attributed to a fine grain size (2–3 μm) and the accompanying diffusional creep and grain boundary sliding. This presentation discusses our findings to date and includes microstructural studies and tensile properties, both at room temperature in air and 1000°C in vacuum. 16 refs., 4 figs., 3 tabs.

28533 (CONF-9006122–5) **Micro-mechanical modeling of crack growth resistance in a carbon/carbon composite.** Jenkins, M.G. (Oak Ridge National Lab., TN (USA)); Ghosh, A.; Okura, Akimitsu. Oak Ridge National Lab., TN (USA). [1990]. 13p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From International conference on micromechanics of failure of quasi-brittle materials; Albuquerque, NM (USA); 7-8 Jun 1990. Order Number DE90009407. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Micro-mechanics fracture models are incorporated into three distinct fracture process zones which contribute to the crack growth resistance of fibrous composites. The frontal process zone includes micro-cracking, fibre debonding, and some fibre failure. The elastic process zone is related only to the linear elastic creation of new matrix and fibre fracture surfaces. The wake process zone includes fibre bridging, fibre pullout, and fibre breakage. The R-curve predictions of the numerical model compare well with empirical results for a unidirectional (UD), continuous fibre C/C composite. Separating the contributions of each process zone reveals the wake region to contain the dominant crack growth resistance mechanisms. 31 refs., 5 figs., 1 tab.

28534 (CONF-9006135–1) **Catalytic decomposition of S_2F_{10} and its implications on sampling and detection from SF_6-insulated equipment.** Olthoff, J.K. (National Inst. of Standards and Technology, Gaithersburg, MD (USA)); Van Brunt, R.J.; Herron, J.T.; Sauers, I.; Harman, G. Oak Ridge National Lab., TN (USA). [1990]. 20p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From 1990 IEEE international symposium on electrical insulation; Toronto (Canada); 3-6 Jun 1990. Order Number DE90008571. Available from NTIS, PC A03/MF A01 - OSTI.

Recent findings indicate that S_2F_{10} is unstable with respect to decomposition on a surface. This paper reports the first results of a study investigating the mechanisms and rates of surface decomposition of S_2F_{10} under various conditions. Initial results indicate that surface decomposition rates on stainless steel increase with increased water content, temperature, and surface-to-volume ratio, and with decreased gas pressure. The implications of these results for the preparation and storage of S_2F_{10} samples are discussed. Additionally, the use of this surface decomposition mechanism to enhance the detection sensitivity of small concentrations of S_2F_{10} in SF_6 using a gas chromatograph/mass spectrometer (GC/MS) is investigated. Detection sensitivities of 1 ppM by volume (ppM_v) of S_2F_{10} in SF_6 are routinely achievable using this new technique. 14 refs., 8 figs.

28535 (EUR–12057) **Influence of chloride admixtures on cement matrix durability.** Sheikh, I.A. (Pakistan Atomic Energy Commission, Islamabad (Pakistan)); Zamorani, E.; Serrini, G. Commission of the European Communities, Luxembourg (Luxembourg). 1989. 15p. Available from NTIS (US Sales Only), PC A03/MF A01.

The influence of various inorganic salts, as chloride admixtures to Portland cement, on the mechanical properties and the durability of the matrix has been studied. The salts used in this study are chromium, nickel and cadmium chlorides. Improved compressive strength values are obtained which have been correlated to the stable metal hydroxide formation in high pH environment. Under static water conditions at 50°C, hydrolyzed chloride ions exhibit adverse effects on the matrix durability through rapid release of calcium as calcium chloride in the initial period of leaching. On the contrary, enhanced matrix durability is obtained on long term leaching in the case of cement containing chromium chloride.

28536 (JAERI-M–89-203) **Studies on radiation resistance of fiber reinforced plastic composites featured by easiness of manufacturing, 3: Mechanical properties of high radiation resistant FRP.** Udagawa, Akira (Japan Atomic Energy Research Inst., Takasaki, Gunma (Japan). Takasaki Radiation Chemistry Research Establishment); Sasuga, Tsuneo; Seguchi, Tadao. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 26p. (In Japanese). Order Number DE90777751. Available from NTIS (US Sales Only), PC A03/MF A01.

Mechanical properties of glass fiber-reinforced plastics (GFRP) irradiated at room temperature with electron beams were studied in order to characterize the radiation resistance. Mechanical properties were tested by flexural strength and interlaminar shear strength (ILSS) at room and low temperature, and flexural fatigue strength at room temperature. The GFRP used in the present study were manufactured trial with three kinds of epoxy matrices having excellent radiation resistance at room temperature and easiness of manufacturing. These composites prepared in selected curing condition were equipped with high flexural strength at low temperature, about two times at room temperature. GFRP composed of 4,4'-tetraglycidyl diamino diphenyl methane cured with 4,4'-diamino diphenyl methane showed the highest radiation resistance: the strength after irradiation up to 90 MGy were kept the initial value, that is, flexural strength of 1000 MPa at 77 K and ILSS of 70 MPa at 123 K. It was also confirmed that the flexural strength measured at 4.2 K were well agreed with the values

tested at 77 K. On the effects of fiber-matrix bonding materials by using different kinds and/or amount of silane coupling agents, the pronounced difference were found in the degradation behavior but did not affect to the flexural strength of the GFRP. Flexural fatigue behavior showed rather well radiation degradation comparing with three point bending strength at room temperature. (author).

28537 (KEK–89-2, pp. 172-177) **Performance of carbon as vacuum material and its degassing rate.** Katoh, Shigeki (Institute of Physical and Chemical Research, Wako, Saitama (Japan)); Oyama, Hitoshi; Odagiri, Hitoshi. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

An ideal surface with a low degassing rate must be low in attachment coefficient, activation energy for desorption, solubility, diffusion coefficient, and surface roughness coefficient. In the present work, carbon is selected as material that meet these requirements. In particular, it focuses on steel coated with carbon by the ECR plasma technique since pure carbon is not suitable as structural material. A permanent magnetic is employed to produce a resonant magnetic field, and the degassing rate is measured before and after the treatment. In addition, measurements are made of the activation energy for the desorption of water vapor from steel and carbon. Results demonstrate that a large steel surface can be coated satisfactorily with carbon by the ECR plasma technique using a permanent magnet. Steel surface and carbon film are exposed to steam, and the change in degassing rate is measured for 24 hours. The degassing rate is found to be largely decreased by the treatment. The ratio of the degassing rate of the carbon film to that of the steel is about 1/70 in 5 min and 1/5 in 60 min, respectively. The activation energy of desorption for graphite is significantly smaller than that for steel. (N.K.).

28538 (KEK–89-2, pp. 178-182) **Simulation of gas release characteristics of ultra-high vacuum equipment coated with carbon film with low degassing rate.** Odagiri, Hitoshi (Toshiba Corp., Kawasaki, Kanagawa (Japan)); Oyama, Hitoshi; Katoh, Shigeki. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

Low in degassing rate, carbon film produced by ECR plasma is expected to have good vacuum-engineering characteristics. In particular, it is hopeful as material for ultra-high vacuum equipment because water is not adsorbed significantly and, if adsorbed, can be desorbed easily. This suggests that equipment coated with carbon can achieve an ultra-high vacuum. Furthermore, carbon coating may make it possible to develop so-called room-temperature- pumped ultra-high vacuum equipment. In the study, the gas release characteristics of ultra-high vacuum equipment is simulated by a simple method based on degassing rate measurements. These measurements show that water is the major component of the released gas. The degassing rate decreases linearly with time. Thus, water vapor release characteristics can be determined from the time dependence of the pressure on the Freundrich-type adsorption isotherm. Simulation results indicate that vacuum equipment coated with carbon can achieve an ultra-high vacuum rapidly without baking. It is expected that surface with better vacuum-engineering characteristics would be obtained by improving the quality of film by optimizing the ECR plasma application conditions. (N.K.).

28539 (KIB-RUB-TWM–85-6, pp. 119-130) **Effects of cement materials and fluxes on the properties of sprayed concrete.** Mueller, L. (Heidelberger Zement AG, Leimen (Germany, F.R.)). Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau. Sep 1985. (In German). (CONF-8502162–: 3. colloquium on sprayed concrete for tunneling and mining, Bochum (Germany, F.R.), 13 Feb 1985). In *Sprayed concrete for tunneling and mining.* Available from Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau.

After reviewing the chemical effects of cement, the author discusses the chemical effects of fluxes, e.g. accelerators, stabilizers, and retarding agents. (MOS).

28540 (KIB-RUB-TWM–85-6, pp. 131-145) **Materials technology on the construction site.** Wandschneider, R. (Heitkamp GmbH, Herne (Germany, F.R.)). Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau. Sep 1985. (In German). (CONF-8502162–: 3. colloquium on sprayed concrete for tunneling and mining, Bochum (Germany, F.R.), 13 Feb 1985). In *Sprayed concrete for tunneling and mining.* Available from Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau.

Sprayed concrete as specified in DIN 18 551 is a mixture of fluxes and binders which is compacted by spraying onto a counterbearing and, according to DIN 1045, has a maximum grain size over 8 mm. In the dry spraying process, rebound can be prevented in principle, so that the initial mixture and the final concrete will differ in a certain degree. The article discusses ready-mixed concrete, the initial mixture, rebound, the initial materials, and the precalculation and proof of concrete strength. (MOS).

28541 (KIB-RUB-TWM–85-6, pp. 163-180) **Anisotropic properties of steel-fiber-reinforced sprayed concrete.** Borttscheller, M. (Bochum Univ. (Germany, F.R.). Lehrstuhl fuer Bauverfahrenstechnik und Baubetrieb). Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau. Sep 1985. (In German). (CONF-8502162–: 3. colloquium on sprayed concrete for tunneling and mining, Bochum (Germany, F.R.), 13 Feb 1985). In *Sprayed concrete for tunneling and mining.* Available from Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau.

A method of determining the fiber content, distribution and orientation in steel-fiber-reinforced sprayed concrete on a stereological basis. This 'radiological general structural analysis' is used for an investigation of the influence of several 'fiber-specific' influencing parameters of the initial mixture on the structure of the finished concrete. The influence of the fiber orientation is investigated for the example of the stress-strain behaviour - load at rupture and energy uptake - in a uniaxial pressure experiment, and its relevance for different loading directions is discussed. (orig.).

28542 (KIB-RUB-TWM–85-6, pp. 181-190) **Shotcrete modified by epoxide resin.** Schorn, H. (Bochum Univ. (Germany, F.R.). Arbeitsgruppe Materialtechnologie und Konstruktionen des Massivbaues). Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau. Sep 1985. (In German). (CONF-8502162–: 3. colloquium on sprayed concrete for tunneling and mining, Bochum (Germany, F.R.), 13 Feb 1985). In *Sprayed concrete for tunneling and mining.* Available from Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau.

Not all concrete mixes containing portland cement paste and polymers are real polymer modified concretes. Those materials are determined by a combined binder effect of both, portland cement and polymer or reactive resin, respectively. Investigations of material structure, not only simple material tests are necessary for showing this effect. A polymer modified material using an emulgated epoxy resin has been developed for shotcreting process especially. (orig.).

28543 (MLM–3631) **An alternate interconnect method for joining flexible circuits using conductive adhesives.** Schurman, W.R. EG and G Mound Applied Technologies, Miamisburg, OH (USA). 17 Apr 1990. 21p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. Order Number DE90008194. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Conductive adhesives were evaluated as a labor-saving alternate method for interconnecting flexible circuit layers in slapper detonators. Short-term aging, high temperature and high humidity storage, thermal cycle, and thermal shock studies were done. The adhesive interconnections were also studied under the high voltage and high current operating conditions of a slapper detonator. In all tests, interconnections made with conductive adhesive compared favorably with standard diffusion bonded joints, demonstrating the feasibility of joining flexible circuit components without metallic solders,

brazes, thermo-compression bonds, diffusion bonds, or welds. 8 refs., 4 figs., 5 tabs.

28544 (N–90-15766) **Bridgman crystal growth. Final report.** Carlson, F. Clarkson Univ., Potsdam, NY (USA). Jan 1990. 59p. (NASA-CR–186204;NAS–1.26:186204). Available from NTIS, PC A04/MF A01.

The objective of this theoretical research effort was to improve the understanding of the growth of Pb(x)Sn(1-x)Te and especially how crystal quality could be improved utilizing the microgravity environment of space. All theoretical growths are done using the vertical Bridgman method. It is believed that improved single crystal yields can be achieved by systematically identifying and studying system parameters both theoretically and experimentally. A computational model was developed to study and eventually optimize the growth process. The model is primarily concerned with the prediction of the thermal field, although mass transfer in the melt and the state of stress in the crystal were of considerable interest. The evolution is presented of the computer simulation and some of the important results obtained. Diffusion controlled growth was first studied since it represented a relatively simple, but nontheless realistic situation. In fact, results from this analysis prompted a study of the triple junction region where the melt, crystal, and ampoule wall meet. Since microgravity applications were sought because of the low level of fluid movement, the effect of gravitational field strength on the thermal and concentration field was also of interest. A study of the strength of coriolis acceleration on the growth process during space flight was deemed necessary since it would surely produce asymmetries in the flow field if strong enough. Finally, thermosolutal convection in a steady microgravity field for thermally stable conditions and both stable and unstable solutal conditions was simulated.

28545 (NAGRA-NTB–88-22) **Conservation of organic materials over several thousand years.** Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). May 1988. 79p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

Based on the current design of repositories for medium and low level radioactive waste, substantial amounts of organic substances will be a component of the waste to be deposited. Little is known regarding the potential degradation of these organic substances. Their long-term behaviour is of great importance for a safety and risk assessment. This report is the result of the joint work of archeologists and chemists. Archeological and (pre)historical 'analogs' having a chemical composition that resembles that of the substances to be deposited were used in order to evaluate the long-term stability of organic compounds. The organics that were best suited for this study included birchtree pitch as well as resins. These organic substances are surrogates for bitumen, which is used in large quantities as a solidifying matrix for radioactive wastes. These surrogate bituminous materials were analyzed and identified by gas chromatography and IR-spectroscopy. Wood samples also provide important information. For analysis of the wood samples, the fractions of cellulosis and lignin were quantified. The stability of bituminous compounds can be estimated by the age of the recovered material which was as old as 50'000 years. In Switzerland the oldest wood samples are from the mesolithic period and have an age of approximately 8'000 years. To establish a correlation between the degree of preservation of the organic 'surrogate' samples (particularly wood) and the properties of different soils, several parameters were investigated including redox potential, fraction of organic carbon, water content and pH. Saturation with water, absence of dissolved oxygen, strongly negative redox potential, low microbial activity, low temperature, negligible convective transport of substances and no disturbances promote the long-term preservation of organic material and wood. (author) 13 figs., 18 tabs., 17 refs.

28546 (PB–90-163254/XAB) **Determination of fiber/matrix interfacial properties of ceramic and glass matrix composites. Interim report, 1 January 1986-1 January 1988.** Cranmer, D.C. National Inst. of Standards and Technology (IMSE), Gaithersburg, MD (USA). Ceramics Div. Feb 1990. 76p. (NISTIR–89/4079). Available from NTIS, PC A05/MF A01.

The work described is primarily related to the development and use of several techniques for determining the fiber/matrix interfacial properties of ceramic and glass matrix composites. The specific techniques utilized are the double cleavage drilled compression (DCDC), indentation push-in, indentation push-out, and single fiber pull-out tests. The DCDC test provides direct experimental observation of the crack-fiber interactions. The indentation techniques and the pull-out test provide information on the debond strength of the fibers from the matrix and interfacial frictional stress required to pull the fibers out of the matrix. The emphasis has been on understanding what happens at the interface, and has focused on several model systems including SiC monofilament reinforced glasses (borosilicate, soda-lime-silica), and SiC fiber reinforced glass-ceramic. Measurements have been made of the interface properties as well as on the increase in toughness as a crack approaches the reinforcing fibers. Some of the effects of interface chemistry on the properties have also been considered.

28547 (PB–90-860859/XAB) **Ion exchange resins. February 1983-February 1990 (A Bibliography from the NTIS data base). Report for February 1983-February 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 153p. Available from NTISPC N01/MF N01.

Supersedes PB–86-863065.

This bibliography contains citations concerning the preparation and applications of ion exchange resins. Their use as catalysts and in treatment of water and wastes, chemical analysis and reactions, nuclear fuels and reactors, and in various recovery, purification, and separation processes are discussed. Performance evaluations are also included relative to air-purification processes. (This updated bibliography contains 280 citations, 129 of which are new entries to the previous edition.)

28548 (SAND–90-0507C) **Localization of deformation in brittle rock: Theoretical and laboratory investigations.** Wawersik, W.R. (Sandia National Labs., Albuquerque, NM (USA)); Olsson, W.A.; Holcomb, D.J.; Rudnicki, J.W.; Chau, K.T. Sandia National Labs., Albuquerque, NM (USA). [1990]. 10p. Sponsored by U.S. DOE Defense Programs; National Science Foundation. DOE Contract AC04-76DP00789. Grant MSM-8612876. (CONF-9006122–2: International conference on micromechanics of failure of quasi-brittle materials, Albuquerque, NM (USA), 7-8 Jun 1990). Order Number DE90008500. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Constitutive modeling and bifurcation analyses are combined with axisymmetric (triaxial), triaxial/torsion, and plane-strain experiments to interpret and anticipate the development of shear localization in rocks. This paper discusses preliminary results. 22 refs., 3 figs.

28549 (SAND–90-0541C) **A continuum damage model for the quasi-static response of brittle materials.** Chen, E.P. (Sandia National Labs., Albuquerque, NM (USA)); Tzou, D.Y. Sandia National Labs., Albuquerque, NM (USA). [1990]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9006122–1: International conference on micromechanics of failure of quasi-brittle materials, Albuquerque, NM (USA), 7-8 Jun 1990). Order Number DE90007681. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An isotropic continuum damage theory which accounts for the degradation of material strength under quasi-static loading conditions has been developed in the present investigation. The damage mechanism in this theory has been selected to be the interaction and growth of subscale cracks. The development of the theory follows closely the strain-rate dependent dynamic model advanced by the first author and his coworkers. Briefly, the cracks are activated by the maximum principal tensile strain and the density of activated cracks is described by a Weibull statistical distribution. The moduli of a cracked solid derived by Budiansky and O'Connell are then used to represent the global material degradation due to subscale cracking. Two additional material constants have been introduced in this model. These constants are determined from uniaxial tensile test data. The model has been implemented into a finite element code. Sample calculations involving the uniaxial and biaxial responses of plain concrete panels are presented to demonstrate the utility of the model. 7 refs., 2 figs.

28550 (SAND–90-0608C) **Increased stuck-at fault coverage with reduced I_{DDQ} test sets.** Fritzemeier, R.R. (Sandia National Labs., Albuquerque, NM (USA)); Soden, J.M.; Treece, R.K.; Hawkins, C.F. New Mexico Univ., Albuquerque, NM (USA). Dept. of Electrical and Computer Engineering. [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005158–1: 1990 AT&T conference on electronic testing, Princeton, NJ (USA), -10 May 1990). Order Number DE90009509. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Simplified ATPG and fault simulation algorithms, reduced test set sizes, and increased fault coverage are achieved with I_{DDQ} testing for stuck-at faults. In addition, I_{DDQ} testing will detect logically redundant and multiple stuck-at faults, and improve the detection of non-stuck-at fault defects. 17 refs., 6 figs., 6 tabs.

28551 (SAND–90-0613C) **CMOS IC I_{DDQ} testing for the 1990s.** Soden, J.M. (Sandia National Labs., Albuquerque, NM (USA)); Fritzemeier, R.R.; Guth, J.R.; Hawkins, C.F. Sandia National Labs., Albuquerque, NM (USA). [1990]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004174–1: VLSI test symposium, Atlantic City, NJ (USA), 10-11 Apr 1990). Order Number DE90009508. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Significant improvements in CMOSIC quality, reliability, and fabrication yield can be readily achieved in the 1990s by appropriate implementation of tests for quiescent power supply current (I_{DDQ}). As part of an overall quality management program, I_{DDQ} testing incorporated with design for testability and modified conventional logic response testing enables 100% stuck-at fault coverage, quality improvement goals of defective levels less than 100 PPM, and reliability greater than 0.999 for 30 years. 9 refs., 2 figs., 1 tab.

28552 (SAND–90-0890C) **Experimental evaluation of chemical cleaning processes for high-lifetime silicon processing.** King, D.L.; McBrayer, J.D.; Basore, P.A.; Buck, M.E.; Tingley, J.W.; Gee, J.M.; Hansen, B.R.; Ruby, D.S. Sandia National Labs., Albuquerque, NM (USA). [1990]. 12p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-9003139–1: Materials research center of excellence seminar, El Paso, TX (USA), 5 Mar 1990). Order Number DE90009332. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The first in a series of multi-factor experiments designed to optimize the chemical cleaning procedure for four types of silicon material used in solar cell fabrication has been completed. The goal of this first experiment (a twenty-two factor main-effects experiment) was to determine the factors associated with chemical cleaning procedures that are most important in obtaining high excess charge-carrier recombination lifetime following a high-temperature furnace oxidation. It was determined that the factors having the strongest influence on charge-carrier lifetime were different for the four different silicon materials considered. In general, the lower the lifetime of the material, the less sensitive the material was to different chemical cleaning steps. The stability of the lifetime was also evaluated with several factors exhibiting a significant effect for high-quality silicon. Chemical cleaning procedures were identified that resulted in stable post-oxidation lifetimes greater than 2 ms for high-resistivity float-zone silicon. 3 refs., 8 figs.

28553 (UCID–21761) **Mechanical testing of selected engineering plastics.** Scott, J.J.; Brady, R.L. Lawrence Livermore National Lab., CA (USA). 22 Jan 1990. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008186. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Tensile stress-strain curves and tensile creep curves were generated for a number of candidate engineering plastics. Creep testing was performed with a sustained stress of 5000 psi. Both unfilled and filled (fiber-reinforced) plastics were investigated. Nominal fill levels were 30% and 60% of either chopped carbon or glass fibers. 1 fig., 2 tabs.

28554 (UCRL–102603) **Towards a constitutive model for cemented granular materials.** Margolin, L.G.; Trent, B.C. Lawrence Livermore National Lab., CA (USA). 4 Jan 1990. 10p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-900646–6: 31. US symposium on rock mechanics, Golden, CO (USA), 18-20 Jun 1990). Order Number DE90006261. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

For several years we have been embarked on a program to understand the response of cemented granular materials to large deformations at high strain rates. A typical problem of interest is the formation of a crater in alluvium by a nuclear explosion (Margolin, et al., 1988). Our goal is to construct a constitutive model that represents the complex behavior of such materials and yet is simple enough to use in large scale calculations based on computer programs that model solid continuum dynamics. The purpose of this paper is to describe the process of creating the analytic model. We will derive an expression for the effective elastic moduli expressed as integrals over the configurations of the average grain. These integrals depend on probability distributions for the number of bonds, their lengths, and their relative orientations. The form of these probability distributions will vary for different materials and depends on the process by which the material was formed. We do not discuss this point in this paper. Instead, we will make some reasonable assumptions for the probability distributions and go on to evaluate the qualitative dependencies of the effective moduli. Our final results show that the Youngs' modulus of the granular assembly should vary linearly with the area of the bond, the number of bonds per grain (i.e., the coordination number), the expected length of the bond, and the Youngs' modulus of the bonding material. Also, Poisson's ratio should be 0.25. We verify these dependencies numerically with calculations in our modified TRUBAL code. 5 refs., 4 figs., 1 tab.

28555 (UCRL-CR–103145) **Silicon field emission points for vacuum IC's by wet chemical etching.** Hunt, C.E. (California Univ., Davis, CA (USA). Dept. of Electrical Engineering and Computer Science); Trujillo, J. Lawrence Livermore National Lab., CA (USA); California Univ., Davis, CA (USA). Dept. of Electrical Engineering and Computer Science. Mar 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90009533. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The initial vacuum integrated circuits project has consisted of the fabrication of sharp silicon field emission tips and measuring field emission from these tips. Mask sets were designed for fabricating both vertical and horizontal discrete vacuum microelectronic devices. The project is now ready for continuation into the device fabrication phase. 3 figs., 1 tab.

28556 **Adhesion in solids.** Materials Research Society symposium proceedings. Volume 119. Mattox, D.M. (Sandia National Labs., Albuquerque, NM (USA)); Baglin, J.E.E.; Gottschall, R.J.; Batich, C.D. 312p. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804117–: Adhesion in solids, Reno, NV (USA), 5-7 Apr 1988).

These proceedings contain 40 papers under the headings of: Fracture mechanics, Fracture mechanics and tribology, postdeposition treatments, Deposited inorganic films, Adherence of natural layers and surface treatment of polymers, Surface of polymers and analytical techniques, Analytical techniques.

28557 **Low-density microcellular polymer foams: Applications in biomaterials.** Sylwester, A. (Sandia National Laboratories, Alburquerque, (NM)); Aubert, J.; Rand, P. pp. 806 of Biomedical materials and devices. Hanker, J.S.; Giammara, B. L. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AC04-76DP00789. (CONF-8711102–: Symposium on biomedical materials and devices, Boston, MA (USA), 30 Nov - 4 dec 1987).

Microcellular polymer foams are of interest as biomaterials for uses such as artificial skin, synthetic vascular replacements, artificial organs, and for use in permeable drug delivery systems. The authors report the use of thermally-induced phase separation as a technology by which a variety of polymer foams can be prepared. This process permits control of foam morphology, cell size, and density. Importantly, the phase separation process results in fully-open-celled foam structures. Additives such as small molecules and functionalized polymers have been incorporated into these microcellular foams resulting in polymer surfaces with controlled porosity and chemical modification. Microcellular polyurethane

foams, with chemically modified surfaces, have potential application as small-diameter vascular replacements.

28558 A semi-empirical potential for graphite. Oh, D.J. (Materials Science Dept.., Univ. of Virginia, Charlottesville, VA (US)); Johnson, R.A. pp. 471 of Atomic scale calculations in materials science. Tersoff, J.; Vanderbilt, D.; Vitek, V. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811147–: Symposium on atomic scale calculations in materials science, Boston, MA (USA), 28-30 Nov 1988).

This paper discusses an embedded atom method model for graphite based on a short-range Morse two-body potential and an electron density function with both radial and angular terms. This part of the model involves interaction only within a hexagonal plane, and the interaction between planes is approximated by a Buckingham potential. The model is stable with respect to fcc, bcc, and diamond structures. The effective two-body potential is very small, indicating that defect properties are dominated by the noncentral many-body interactions.

28559 Quantitative studies of the effect of adhesion on the mechanical and physical properties of polymer composites. Williams, J.W. (Florida Univ., Gainesville, FL (USA). Dept. of Materials Science and Engineering); Shang, S.W.; Sacks, M.D. pp. 312 of Adhesion in solids. Mattox, D.M.; Baglin, J.E.E.; Gottschall, R.J.; Batich, C.D. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804117–: Adhesion in solids, Reno, NV (USA), 5-7 Apr 1988).

Young's modulus, tensile strength and the storage shear modulus experiments were performed on silica-filled ethylene-vinyl acetate composites and the results were correlated with polymer-filler interaction energy. The polymer-filler interaction energy was determined by wetting and infrared spectroscopy experiments. The interaction energy was characterized by the work of adhesion. The results indicate there is a strong correlation between modulus and tensile strength and the work of adhesion. There was an exponential relationship of modulus and tensile strength with the reciprocal of the work of adhesion.

28560 Dynamics of rapid solidification in silicon. Peercy, P.S. (Sandia National Labs., Albuquerque, NM (USA)); Thompson, M.O.; Tsao, J.Y. pp. 462 of Science and technology of rapidly quenched alloys. Tenhover, M.; Johnson, W.L.; Tanner, L.E. Materials Research Society, Pittsburgh, PA (USA) (1987). DOE Contract AC04-76DP00789. (CONF-861207–: Materials Research Society fall meeting, Boston, MA (USA), 1-5 Dec 1986).

The authors report real-time techniques used to study rapid melt and solidification dynamics in silicon. In crystalline Si, the interface response function was characterized and found to be asymmetric for large deviations from the melting temperature, which will require reevaluation of conventional transition state treatments of melt and solidification. In amorphous Si, the mechanism of explosive crystallization was studied. The explosive transformation is mediated by a buried liquid layer, and detailed measurements have led to the suggestion that polycrystalline Si nucleates at the moving liquid-amorphous interface. For certain condition, this process could yield fine-grained polycrystalline Si; for other conditions it permits epitaxial regrowth from the underlying crystalline Si for maximum melt thickness much less than the original amorphous layer thickness.

28561 Micromechanics and microdynamics via atomistic simulations. Landman, U. (School of Physics Georgia Institute of Technology Atlanta, GA (US)); Luedtke, W.D.; Ribarsky, M.W. pp. 524 of New materials approaches to tribology: Theory and applications. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

Basic understanding of the structure and dynamics of materials and their response to external perturbations requires knowledge on the microscopic level, of the underlying energetics and atomic dynamics, whose consequences we observe and measure. Coupled with the above is the everlasting quest to observe and understand natural phenomena on refined microscopic scales, which provides the impetus for the development of experimental and theoretical techniques for the interrogation of materials with refined spatial and temporal resolution. In this paper the authors review the development of molecular dynamics simulations for studies of the energetics and dynamical response of materials to external mechanical perturbations. Applications to investigations of solid and liquid interfacial systems under stress and to studies of the consequences of tip-substrate interactions in atomic force microscopy are demonstrated.

28562 Interface tribology via nonequilibrium molecular dynamics. Hoover, W.G. (Lawrence Livermore National Lab., Post Office Box 808, Livermore, CA (USA)); Hoover, C.G.; Stowers, I.F.; Siekhaus, W.J. pp. 524 of New materials approaches to tribology: Theory and applications. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

By borrowing ideas from control theory, nonequilibrium molecular dynamics incorporates temperature, stress, and heat flux directly into atomistic, time-reversible, deterministic equations of motion. The authors are applying this technique to studies of surface indentation, surface cutting, friction, ablation, and condensation. They describe simulations of the indentation and the cutting process using two-dimensional crystals composed of a few thousand particles.

28563 Residual stress, fracture, and adhesion in sputter-deposited molybdenum films. Mattox, D.M. (Sandia National Labs., Albuquerque, NM (USA)); Cuthrell, R.E. pp. 312 of Adhesion in solids. Mattox, D.M.; Baglin, J.E.E.; Gottschall, R.J.; Batich, C.D. Materials Research Society, Pittsburgh, PA (USA) (1988). (CONF-8804117–: Adhesion in solids, Reno, NV (USA), 5-7 Apr 1988).

The authors discuss how atomistically deposited films may form with high residual stresses which may be either tensile or compressive in nature. These film stresses represent stored strain energy which may affect the adhesion of the film-substrate couple and in the limit may cause spontaneous fracture at or near the film-substrate interface (loss of adhesion). In the post cathode magnetron sputter deposition of molybdenum films, the authors have found that the intrinsic film stresses are generally anisotropic and may easily exceed the fracture or adhesive strength of the film-substrate couple. The residual stress anisotropy in the film is dependent on the orientation with respect to the post cathode and the magnitude and nature of the stresses are very dependent on the deposition conditions, particularly gas pressure during sputtering. By using a pressure-cycling technique. The authors have deposited thick (5 microns) films of molybdenum which have little residual stress or stress anisotropy.

28564 Atomistic simulation of silicon grain boundaries. Phillpot, S.R. (Materials Science Div., Argonne National Lab., Argonne IL (US)); Wolf, D. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract W-31-109-ENG-38. (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

The bond-bending and bond-stretching three-body potential of Stillinger and Weber is used to study the energy and structure of grain boundaries in silicon.

28565 Applications of lightweight composite materials in pulsed rotating electrical generators. Walls, W.A. (Texas Univ., Austin, TX (USA). Center for Electromechanics); Maifold, S.M. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. IEEE Service Center, Piscataway, NJ (USA) (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

Present rotating electrical pulse power generators are limited in energy storage capability, specific energy, and peak power density by the use of iron-magnetic circuits. This paper discusses lightweight and compact iron-core homopolar generators (HPGs) which have attained specific energies of 6 kJ/kg and have the potential to achieve 8 kJ/kg in the near future. Prototype iron based pulsed alternators are the favored choice for high power to mass ratio applications and have estimated peak ratings of 180 kW/kg.

In terms of total energy storage capability, these machines are limited to several hundred MJ due to the availability of large steel forgings for rotors and basic design considerations including rotor dynamics, allowable rotor tip speeds, and present high speed current collection technology.

28566 Photolithography of polytetrafluoroethylene for tailored adhesion. Rye, R.R. (Sandia National Labs., Albuquerque, NM (USA)); Martinez, R.J. pp. 312 of Adhesion in solids. Mattox, D.M.; Baglin, J.E.E.; Gottschall, R.J.; Batich, C.D. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract AC02-80ER10746. (CONF-8804117–: Adhesion in solids, Reno, NV (USA), 5-7 Apr 1988).

Irradiation of polytetrafluoroethylene (PTFE) with Mg ($K\alpha$) x-rays is shown to protect the surface against the chemical etching steps used to prepare PTFE for adhesion. Pre-irradiated etched samples of PTFE have adhesions strengths of less than 3% of that for non-irradiated etched samples. The major portion of this decrease in adhesion strength occurs for x-ray exposures of less than 10 min ~4.8 $\times 10^3$ mrads) and failure in every case occurs in PTFE and not in the bonded transition region. XPS measurements (20 Å sampling depth) show little difference in F content between irradiated and non-irradiated samples, but thermal desorption shows increasing fluorocarbon desorption with irradiation time. These results are consistent with the known radiation chemistry of PTFE. Irradiation produced free radicals lead to branching and/or cross-linking, and a surface rich in low molecular weight fluorocarbons. The more rigid cross-linked surface is resistant to deep (10,000 Å chemical attack and the bond formed is with a surface rich in short chain flurocarbons. Both a thin boundary region and bonding to short chain species is expected to lead to weak adhesive bonding. Electron irradiation is shown to lead to protection against chemical etching comparable to that obtained with X-rays. With electrons one has the patterns with resolution limited by the beam diameter.

28567 Plasma treatment of polymers for improved adhesion. Kelber, J.A. (Sandia National Labs., Albuquerque, NM (USA)). pp. 312 of Adhesion in solids. Mattox, D.M.; Baglin, J.E.E.; Gottschall, R.J.; Batich, C.D. Materials Research Society, New York, NY (USA) (1988). (CONF-8804117–: Adhesion in solids, Reno, NV (USA), 5-7 Apr 1988).

A variety of plasma treatments of polymer sufaces for improved adhesion are reviewed: noble and reactive has treatment of fluoropolymers; noble and reactive treatment of polyolefins, and plasma-induced amination of polymer fibers. The plasma induced surface chemical and morphological changer are discussed, as are the mechanisms of adhersion to polymeric adhesives, particularly epoxy. Noble has plasma eching of fluoropolymers produces a partially defluorinated, textured surface. The mechanical interlocking of this textured surface is the primary cause of improved adhsion to epoxy. Reactive has plasma also induce defluorination, but oxygen containing gases cause continual ablation of the fluoropolymer surface. Noble and reactive gas (except for hydrogen) etching of polyolefins results in surface oxidation and imrprove adhesion via hydrogen bonding of these exygen containing groups across the interface. The introduction of amine groups to a polymer surface by ammonia or amine plasma treatment generally results in improved adhesion to epoxy. However, amine-epoxy ring interactions can be severely effected by steric factors due to chemical group surrounding the amine.

28568 Thin diamond films for tribological applications. Wong, M.S. (Dept. of Materials Science and Engineering, Northwestern Univ., Evanston, IL (US)); Meilunas, R.; Ong, T.P.; Chang, R.P.H. pp. 524 of New materials approaches to tribology: Theory and applications. Pope, L.E.; Fehrenbacher, L.L.; Winer, W.O. Materials Research Society, Pittsburgh, PA (USA) (1989). NSF-DMR8520280. (CONF-8811278–: New materials approaches to tribology: theory and applications, Boston, MA (USA), 29 Nov - 2 dec 1988).

Diamond films have been deposited on Si, Mo and many other substrates by microwave and radio frequency plasma enhanced chemical vapor deposition. Although the adhesion between the diamond film and most of the metal substrates is poor due to residual thermal stress from the mismatch of thermal expansion coefficients, the authors have developed processes to promote the growth of uniform and continuous diamond films with enhanced adhesion to metal substrates for tribological applications. The tribological properties of these films are measured using a ring-on-block tribotester. The coefficients of friction of diamond films sliding against a 52100 steel ring under the same experimental conditions are found to be significantly different depending on the morphology, grain size and roughness of the diamond films. However, under all cases tested, it is found that for uniform and continuous diamond films with small grain size of 1-3 micrometers, the coefficient of friction of the diamond film sliding against a steel ring under lubrication of a jet of mineral oil is about 0.04.

28569 Amorphous interface between crystalline nickel and titanium films. Walker, F.J. (Metals and Ceramics Div., Oak Ridge National Lab., Oak Ridge, TN (USA)); McKee, R.A.; List, F.A. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract W-31-109-ENG-38. (CONF-8804112–: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

Using in situ reflection high energy electron diffraction and x-ray diffraction, the structure and composition of nickel and titanium multilayer films have been studied. The films were evaporated under UHV conditions at rates of .01 to .1 nm/sec. When deposited on an amorphous NiTi film at 70°C, the individual layers of nickel or titanium are polycrystalline and textured with the layers is amorphous and about 2 nm thick. X-ray scattering from the crystalline layers indirectly shows the composition of the amorphous interface to be Ni rich.

28570 Surface modification of polymeric materials and its effect on blood compatibility. Wrobleski, D.A. (Material and Technology Div. Los Alamos National Lab., Los Alamos, NM (U)); Cash, D.L.; Archuleta, T.; Barthell, B. L.; Dughane, D. V.; Kossowsky, R.; London, J. E.; Lehnert, B.E. pp. 806 of Biomedical materials and devices. Hanker, J.S.; Giammara, B.L. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8711102–: Symposium on biomedical materials and devices, Boston, MA (USA), 30 Nov - 4 dec 1987).

This paper reports the surfaces of commercially available polymeric materials modified through two techniques, the chemical infusion process and physical vapor deposition. The surfaces of poly(methylmethacrylate) (PMMA) have been modified through a chemical infusion process by treatment of the sample with a solution containing varying amounts of titanium (IV) isopropoxide and polyvinylpyrrolidone (PVP). The surfaces of silicone rubber samples have been coated with a thin coating of titanium dioxide with an ion beam sputtering technique. The treated samples were characterized by scanning electron microscopy, optical microscopy, and neutron activation analysis.

28571 Refractive index of amorphous carbon near its K-edge. Spiller, E. (IBM Research Division, T. J. Watson Research Center, Yorktown Heights, New York 10598 (US)). *Applied Optics (USA),* 29(1): 19-23 (1 Jan 1990). DOE Contract AC02-76CH00016.

The refractive index of the amorphous carbon layers inside multilayer soft x-ray mirrors is derived in the Σ = 42–58-A wavelength range by measuring the shift in the Bragg angle caused by refraction. Reflectivity curves are measured with a reflectometer behind a zone plate monochromator at the National Synchrotron Light Source. The monochromator consists only of a freestanding zone plate of gold and an exit slit and is free of any of the contamination problems often found in monochromators that contain mirrors.

28572 Dynamic fringe broadening in multiple line laser Doppler velocimetry. Goosman, D.R. (Lawrence Livermore National Laboratory, P.O. Box 808, Livermore, California 94551 (US)). *Applied Optics (USA),* 29(1): 107-110 (1 Jan 1990). DOE Contract W-7405-ENG-48.

The recently reported multiple line laser Doppler velocimetry technique involves a compromise between laser power and fringe broadening. The present work analyzes the broadening as a function of both the target velocity and the separations of the Fabry-Perot etalons, which in this work do not have to be the same. It is shown that the overlap finesse broadening, which is defined as

the ratio of the frequency separation between fringes to the overlap broadening, depends on the number of free spectral ranges that have occurred due to the velocity of the reflecting target.

28573 NMR and neutron-scattering studies on poly(ethylene oxide) terminally attached at the polystyrene/water interface. Cosgrove, T. (Univ. of Bristol (England)); Ryan, K. *Langmuir (USA),* 6(1): 136-142 (Jan 1990).

Small-angle neutron scattering (SANS) and nuclear magnetic resonance spectroscopy (NMR) have been used to investigate the structure of terminally attached polymers at the polystyrene latex/water interface. In particular, volume fraction profiles obtained by SANS and by the Scheutjens-Fleer meanfield theory of polymer adsorption were used to calculate spin-spin relaxation functions for the adsorbed layer with different adsorbed polymer coverages and chain lengths. These are compared to the experimentally determined relaxation functions obtained by using NMR. There is a good qualitative agreement with the three approaches. The NMR data provide a new insight into the mobility and structure of the adsorbed layer.

28574 Synchrotron radiation studies of poly(tetrafluoroethylene) photochemistry. Rye, R.R. (Sandia National Labs., Albuquerque, NM (USA)); Shinn, N.D. *Langmuir (USA),* 6(1): 142-146 (Jan 1990). DOE Contract AC04-76DP00789.

Irradiation of poly(tetrafluoroethylene) (PTFE) with monochromatic photons in the energy range 25 eV < hv < 1,000 eV protects the surface against alkali etching used to prepare the surface for adhesion. Photon-stimulated desorption (PSD) measurements of neutral fluorocarbon fragments evolved during irradiation have been correlated with the cross-linking kinetics and subsequent etch resistance. Both an increase in the fluorocarbon desorption rate and a decrease in the radiation dose required to achieve a given etch resistance are found for photon energies just above the F(1s) binding energy. Simple kinetic models are used to explain both the initial prompt onset and subsequent linear rise in the fluorocarbon PSD profiles. Mechanistic aspects affecting the efficiency of cross-linking and the use of PSD to monitor this near-surface photochemistry are discussed.

28575 Surface chelation of semiconductors and interfacial electron transfer. Frei, H. (Lawrence Berkeley Lab., CA (USA)); Fitzmaurice, D.J.; Graetzel, M. *Langmuir (USA),* 6(1): 198-206 (Jan 1990). DOE Contract AC03-76SF00098.

The effect of surface chelation of oxide semiconductors on interfacial electron transfer was investigated. The studies employed phenylfluorone (2,6,7-trihydroxy-9-phenylisoxanthen-3-one), PF, as a chelating agent and titanium dioxide as a semiconductor. Pt forms a chelate with surface titanium ions which was characterized by UV-vis and IR spectroscopy. Laser photolysis and cyclic voltametric investigations indicate that surface chelation by PF drastically accelerates the electron transfer from the conduction band of TiO_2 to solution acceptors such as methylviologen.

28576 Electron beam induced current and cathodoluminescence imaging of the antiphase domain boundaries in GaAs grown on Si. Nauka, K. (Hewlett-Packard Company, Palo Alto, California 94304 (USA)); Reid, G.A.; Liliental-Weber, Z. *Applied Physics Letters (USA),* 56(4): 376-378 (22 Jan 1990). DOE Contract AC03-76SF00098.

Electrical and optical properties of antiphase domain boundaries (APBs) in GaAs epitaxial layers grown on Si substrates have been investigated using cathodoluminescence, electron beam induced current, and scanning deep level transient spectroscopy. It was found that APBs reduce near-band-gap luminescence and minority-carrier lifetime. In contrast to recombination at threading dislocations in GaAs films, the nonradiative recombination processes at APBs are not due to deep traps but rather to a continuum of band-gap states introduced by APBs.

28577 Antiphase-domain-free GaAs grown on pseudomorphic Si (100) surfaces by molecular beam epitaxy. Adomi, K. (Coordinated Science Laboratory and Materials Research Laboratory, University of Illinois at Urbana-Champaign, 1101 West Springfield Avenue, Urbana, Illinois 61801 (US)); Strite, S.; Morkoc, H. *Applied Physics Letters (USA),* 56(5): 469-471 (29 Jan 1990). DOE Contract AC02-76ER01198.

GaAs has been grown on pseudomorphic Si (100) surfaces and (100) surfaces misoriented 4° toward [011] and [001] in order to study the quality of the GaAs on Si interface in the absence of misfit dislocations. We obtain completely two-dimensional single-domain GaAs epitaxy after only 80 A of deposition as observed by *in situ* high-energy electron diffraction. Transmission electron microscopy verifies that the GaAs grown on pseudomorphic Si is free of antiphase domains and other notable defects.

28578 Role of band-tail carriers in metastable defect formation and annealing in hydrogenated amorphous silicon. Jackson, W.B. (Xerox Palo Alto Research Center, Palo Alto, California 94304 (US)). *Physical Review, B: Condensed Matter (USA),* 41(2): 1059-1075 (15 Jan 1990).

This paper presents results on annealing of carrier-induced metastable defects in hydrogenated amorphous silicon (*a*-Si:H) and on the dependence of the defect kinetics on carrier density. The metastable defects were studied by measuring the threshold-voltage shifts on capacitors as a function of time, temperature, and bias. The defect generation and annealing exhibit stretched-exponential-like behavior where the characteristic time for defect generation is a function of carrier density. The ratio of carrier density to defects in equilibrium are determined to be approximately 0.1, the same ratio found in doped *a*-Si:H. The results are consistent with dispersive hydrogen motion through an exponential distribution of barrier heights. The hopping rate and the final-state energy depend on the carrier density. This dependence on carrier density explains the carrier-, light-, and doping-induced defect formation in *a*-Si:H. The increase of the hopping rate due to carriers accounts for the increase in the hydrogen-diffusion rate in doped material. While much of the data are consistent with a single-hop model, the lack of correlation between generation and annealing rates indicates that defect formation occurs by multiple hopping.

28579 X-ray specular reflection studies of silicon coated by organic monolayers (alkylsiloxanes). Tidswell, I.M. (Division of Applied Sciences, Department of Physics, Harvard University, Cambridge, Massachusetts 02138 (USA)); Ocko, B.M.; Pershan, P.S.; Wasserman, S.R.; Whitesides, G.M.; Axe, J.D. *Physical Review, B: Condensed Matter (USA),* 41(2): 1111-1128 (15 Jan 1990). DOE Contract AC02-76CH00016.

X-ray specular reflectivity has been used to characterize the structure of silicon–silicon-oxide surfaces coated with chemisorbed hydrocarbon monolayer films (alkylsiloxanes). Using synchrotron radiation the reflectivity was followed over 9 orders of magnitude, from grazing incidence to an incident angle of $\phi \approx 6.5°$, or $q=(4\pi/\lambda)\sin(\phi)=0.8\ A^{-1}$, allowing a spatial resolution of features approximately $\pi/0.8 \approx 4.0$ A along the surface normal. Analysis was performed by fitting the data to reflectivities calculated from models of the surface electron density and by calculating Patterson functions directly from the data. Although the measured reflectivities could be equally well described by different sets of model parameters, the electron densities calculated from these different parameters were remarkably alike. Inspection of the electron densities allowed identification of a layer of SiO_2 (≈17-A thick), a layer of head-group region where the alkylsiloxane adsorbs to the SiO_2, and the hydrocarbon layer. Fitting the data also required that the various interfaces have different widths. The fact that the same local hydrocarbon density of 0.85 g/cm^3 was observed for both fully formed and partially formed monolayers with alkane chains of varying length excluded a model in which the partially formed monolayer was made up of separated islands of well-formed monolayers. Measurements before and after chemical reaction of a monolayer in which the alkyl chain was terminated by an olefinic group demonstrated the ability to use x-ray reflectivity to characterize chemical changes. The effects of radiation damage on these types of measurements are described.

28580 Small-angle neutron scattering from micelles of potassium salts of 18-carbon fatty acids. Johnson, J.S. Jr. (Oak Ridge National Lab., TN (USA)); Griffith, W.L.; Compere, A.L. *Langmuir (USA),* 5(5): 1191-1195 (Sep-Oct 1989). DOE Contract AC05-84OR21400.

Small-angle neutron-scattering patterns from micelles of potassium salts of five octadecacarboxylic acids, differing only in number of double bonds or configuration, are reported. Degrees of aggregation vary between about 100 for potassium linolenate (three double bonds) to about 190 for potassium stearate (saturated). There is a modest trend in all cases toward decreasing molecular weight with increasing temperature, from 25 to 50°C. Results as a function of concentration with oleate indicate an increase in micellar size with increasing concentration between 0.025 and 0.14 M. At the lower end of extended length of the hydrocarbon chain, a model of monodisperse spheres with a rough surface (penetration of water into hydrocarbon to a depth of a few methylenes) cannot be distinguished from bolate or prolate ellipsoids with a dry core. For the longer extended lengths (oleate, elaidate, and stearate), prolate ellipsoids of small asymmetry (up to axial ratio of about 1.75 for stearate) give substantially better fits to the scattering patterns.

28581 **Poly(heterocycle) Langmuir-Blodgett films.** Yang, X.Q. (Brookhaven National Lab., Upton, NY (USA)); Chen, J.; Hale, P.D.; Inagaki, T.; Skotheim, T.A.; Fischer, D.A.; Okamoto, Y.; Samuelsen, L.; Tripathy, S.; Hong, K. *Langmuir (USA)*, 5(6): 1288-1292 (Nov-Dec 1989). DOE Contract FG02-84ER13289.

Two types of poly(heterocycle) Langmuir-Blodgett films have been fabricated: (1) copolymers of pyrrole and 3-alkylpyrrole (3-hexadecylpyrrole and octadecylpyrrole) LB films; (2) mixtures of poly(3-alkylthiophene) and stearic acid LB films. The orientation of single-layer and multilayer films on platinum substrates has been studied by near edge X-ray absorption fine structure (NEXAFS) spectroscopy, which also provides information about interaction between the aromatic groups and the metallic substrate. In the case of mixtures of poly(3-alkylthiophene) and stearic acid LB films, the hydrocarbon chains of the stearic acid molecules are highly ordered. The poly(3-alkylthiophene) components, on the other hand, exhibit random orientation of the thiophene moieties. The orientation of the hydrocarbon chain of the poly(3-alkylthiophene) varies with the chain length, from random to highly ordered along the surface normal of the substrate, as the chain length changes from 4 to 18 carbon units.

28582 **The effect of deposition rate on the growth of epitaxial Ge on GaAs (100).** Eres, D. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6056 (US)); Lowndes, D.H.; Tischler, J.Z.; Sharp, J.W.; Haynes, T.E.; Chisholm, M.F. *Journal of Applied Physics (USA)*, 67(3): 1361-1370 (1 Feb 1990). DOE Contract AC05-84OR21400.

The role of deposition rate in the growth of Ge films on GaAs (100) was investigated using a new supersonic free-jet growth technique capable of achieving epitaxial growth rates several orders of magnitude higher than were previously available. The high growth rates are due to two factors: (1) the high arrival rate of digermane source molecules at a heated GaAs surface, and (2) the high thermal decomposition rate of digermane. Dramatic improvements in surface smoothness were observed with increasing deposition rate, while keeping all other deposition parameters fixed. When the arrival rate of digermane molecules was too high, amorphous films were deposited, in agreement with kinetic considerations. The supersonic free-jet growth technique and the microstructural and electrical properties of the resulting Ge films are described.

28583 **Valence-band electronic structure of Zn_3P_2 as a function of annealing as studied by synchrotron radiation photoemission.** Nelson, A.J. (Solar Energy Research Institute, 1617 Cole Boulevard, Golden, Colorado 80401 (US)); Kazmerski, L.L.; Engelhardt, M.; Hochst, H. *Journal of Applied Physics (USA)*, 67(3): 1393-1396 (1 Feb 1990). DOE Contract AC02-83CH10093.

Ultraviolet photoemission (UPS) utilizing synchrotron radiation has been used to characterize changes in the valence-band electronic structure of crystalline Zn_3P_2 as a function of annealing temperature. The Zn_3P_2 crystal was etched in bromine-methanol prior to analysis and annealing was performed in vacuum at 300 and 350 °C after sputter cleaning. The UPS spectra for the virgin material are qualitatively similar to the photoemission results for various II-VI Zn compound semiconductors and a comparison of the Zn 3*d* binding energies with respect to the valence band maximum is presented. The results for the virgin material and the 300 °C anneal are further compared with the theoretically predicted band structure of Zn_3P_2 as determined by a pseudopotential energy band calculation. Loss of phosphorus from the surface and the presence of elemental zinc on the surface after the 350 °C anneal is evident.

28584 **Depth dependence of alkali etching of poly(tetrafluoroethylene): Effect of x-ray radiation.** Rye, R.R. (Sandia National Labs., Albuquerque, NM (USA)); Arnold, G.W. *Langmuir (USA)*, 5(6): 1331-1334 (Nov-Dec 1989). DOE Contract AC04-76DP00789.

Using Rutherford backscattering spectroscopy (RBS), the authors have shown that defluorination due to alkali etching of poly(tetrafluoroethylene) (PTFE or Teflon) extends to a depth of at least 3,000 Å. Equivalent alkali etching after irradiation with Mg Kα X-rays gives no indication of defluorination within the depth resolution of RBS (150 Å); the RBS spectrum is identical with that of a reference PTFE sample. In contrast, X-ray photoelectron spectra (XPS) reveal comparable defluorination for both irradiated and non-irradiated samples. given the sampling depth of XPS and the depth resolution of RBS, this limits the defluorination depth of the irradiated surfaces of PTFE to between 30 and 150 Å.

28585 **Retention of molecular oxygen in zeolites at high temperature.** Suib, S.L. (Univ. of Connecticut, Storrs (USA)); Morse, B.E. *Langmuir (USA)*, 5(6): 1340-1343 (Nov-Dec 1989).

X-ray photoelectron spectroscopy and residual gas analysis experiments were carried out on NaY zeolite at temperatures between −196 and 400°C. The objective of this work was to further understand the 0 1s transition for zeolites since contributions can arise from zeolitic oxygen as well as trapped water. The residual gas analysis data show that molecular oxygen is retained by NaY zeolite to temperatures as high as 400°C. Qualitative trends in the RGA data for O_2 match those of a shoulder in the XPS 0 1s transition, which is assigned to molecular oxygen. These data indicate that zeolites can retain small amounts of O_2 to very high temperature, and this may be one reason for the typical broadness of the 0 1s data for zeolites found throughout the literature.

28586 **Equilibrium surface composition of diblock copolymers.** Green, P.F. (Sandia National Laboratories, Albuquerque, New Mexico 87185-5800 (USA)); Christensen, T.M.; Russell, T.P.; Jerome, R. *Journal of Chemical Physics (USA)*, 92(2): 1478-1482 (15 Jan 1990). DOE Contract AC04-76DP00789.

The surface composition of a series of symmetric diblock copolymers of polystyrene (PS) and polymethylmethacrylate (PMMA) was studied using x-ray photoelectron spectroscopy (XPS). Each copolymer was composed of N segments where N ranged from 270 to 5200. At large N, where the system is highly segregated, the surface is composed only of PS, the lower surface energy component. For smaller N, where the system is in the weak segregation limit, both the PS and PMMA segments coexist at the surface. The surface excess ψ_1 of PS in the weak segregation limit is well described by $\psi_1=\alpha-\beta N^{-1/2}$, in good agreement with mean field predictions. The constants α and β depend on the interactions between the unlike segments on the copolymer chain and on the surface energy differences between the components. We also show that the strength of the segmental interactions in the vicinity of the surface are weaker than from those in the bulk.

28587 **Characterization of neutron radiation damage in GaAs.** Griffin, P.J. (Sandia National Lab., Albuquerque, NM (US)); Luera, T.F.; Kelly, J.G.; Lazo, M.S. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA)*, 36(6): 1937-1944 (Dec 1989). (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

The NJOY and MARLOWE computer codes are used to characterize neutron damage to GaAs. The fidelity of the components that affect the calculated GaAs damage is examined. The initial defect production is found to be a linear function of the damage energy. Recombination of Frenkel pairs and the distribution of vacancies introduce a non-linearity in the residual defect population with respect to the damage energy. Consideration of the defect recombinations only provides a slight improvement in the agreement between measured and calculated damage in GaAs but does indicate the areas where more work is needed.

28588 Swelling equilibria for ionized temperature-sensitive gels in water and in aqueous salt solutions. Beltran, S. (Chemical Engineering Department, University of California, Berkeley, CA (US)— Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720 (US)); Hooper, H.H.; Blanch, H.W.; Prausnitz, J. *Journal of Chemical Physics (USA)*, 92(3): 2061-2066 (1 Feb 1990). DOE Contract AC03-76SF00098.

Swelling equilibrium data in water and in aqueous NaCl solutions are presented for thermally sensitive N-isopropylacrylamide (NIPA) hydrogels containing 0–4 mol % quaternized amine (positively ionizable) comonomer. We report the effect of gel charge and solution ionic strength on the temperature-induced collapse of NIPA gels. Experimental swelling equilibria are compared with predictions based on a recently proposed oriented-quasichemical model. This model has been shown previously to describe lower critical solution behavior in *uncharged* aqueous polymer solutions and gels (i.e., aqueous NIPA gel). We apply the model here to *ionized* NIPA gel. Semiquantative predictions are obtained for the effects of gel charge and solution ionic strength on temperature-dependent swelling behavior.

28589 Observation of the lowest triplet state in silane by electron energy loss spectroscopy. Tanaka, H. (Argonne National Laboratory, Argonne, Illinois 60439 (US)); Boesten, L.; Kimura, M.; Dillon, M.A.; Spence, D. *Journal of Chemical Physics (USA)*, 92(3): 2115-2116 (1 Feb 1990). DOE Contract W-31-109-ENG-38.

The electron energy loss spetra of silane was recorded at several impact energies and angles. It is concluded that the lowest triplet state of silane is formed from configuration mixing of the 4s Rydberg state with a valence state of the same symmetry.(AIP)

28590 Radiation response of optically-triggered GaAs thyristors. Carson, R.F. (Sandia National Lab., Albuquerque, NM (US)); Hughes, R.C.; Zipperian, T.E.; Weaver, H.T.; Brennan, T.M.; Hammons, B.E.; Klem, J.F. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA)*, 36(6): 2147-2154 (Dec 1989). DOE Contract AC04-76DP00789. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

This paper reports the development of gallium arsenide optically-triggered thyristors that exhibit tolerance to high x-ray dose rates. These two-terminal epitaxial devices feature breakover voltages of 18 V to 38 V with no radiation. They trigger at less than 2 volts with only tenths of mW of laser light, but do not trigger at 2×10^9 Rad(Si)/s with a bias level as much as 40 to 60 percent of the zero-radiation breakover voltage. When these devices are bombarded with neutrons, the reduced carrier lifetimes result in a decreased sensitivity to triggering by light and ionizing radiation.

28591 The corrosion of carbon black anodes in alkaline electrolyte: IV. current eff. for oxygen evolution from metal oxide-impregnated graphitized furnace black. Staud, N. (IBM Magnetic Recording Institute, Almaden Research Center, San Jose, CA (USA)); Sokol, H.; Ross, P.N., Jr. *Journal of the Electrochemical Society (USA)*, 136(12): 3570-3575 (Dec 1989). DOE Contract AC03-76SF00098.

A quantitative method for determining the number of oxygenated carbon atoms in a carbon black sample was developed and applied to the study of oxygen chemisorption on graphitized furnace blacks. It was found that chemisorption of oxygen atoms produced in a low-pressure microwave discharge of argon/oxygen results in the formation of an oxygen complex on every carbon atom exposed on the edge plane surface of these carbons. These combined procedures were then used to titrate the surfaces of a variety of graphitized furnace blacks for the number of edge atoms. The corrosion rate of these carbons was found to be directly proportional to the number of sites titrated by oxygen atom chemisorption, i.e., the number of edge atoms. The number of edge atoms exposed on the surface of graphitized furnace blacks depends on the microstructure of the precursor carbon black and the conditions of graphitization. Catalyzation of these graphitized carbons by NiO has little or no effect on their corrosion rate, which results in current efficiencies for oxygen evolution greater than 98%. The absence of an effect of NiO on the corrosion rate is attributed to the specificity of the corrosion reaction to edge plane sites and an apparent necessity for contact between NiO particles with edge planes for catalyzation of the corrosion reaction by NiO. NiO particles sitting on basal planes, which compose at least 90% of the surface area in these carbons, catalyze only the oxygen evolution reaction.

28592 $\sigma\pi$ charge-transfer excited states of substituted (phenylethynyl)pentamethyldisilanes. Horn, K.A. (Allied-Signal, Inc., Morristown, NJ (USA)); Whitenack, A.A.; Grossman, R.B.; Thorne, J.R.G. *Journal of the American Chemical Society (USA)*, 111(13): 4809-4821 (21 Jun 1989).

A series of substituted (arylethynyl)pentamethyldisilanes was prepared by the palladium(O)-catalyzed coupling of aryl halides and ethynylpentamethyldisilane. The absorption and emission spectra of these acetylenic disinaes were measured over the temperature range from 296 to 77 K in both polar and nonpolar solvents and rigid organic glasses. At 77 K normal $^1(\pi,\pi^*)$ fluorescence and $^3(\pi,\pi^*)$ phosphorescence are observed for those (phenylethynyl)pentamethyldisilanes (1) bearing electron-donating substituents (e.g. 4-MeO). At 77 K those (phenylethynyl)pentamethyldisilanes bearing electron-withdrawing substituents (e.g. 4-NC, 4-CO_2Me) show only a unique intramolecular $^1(\sigma,\pi^*)$ charge-transfer (CT) fluorescence in addition to the $^3(\pi,\pi^*)$ state phosphorescence. Neither ground-state CT complex absorption bands nor exciplex emissions were observed in any of the systems studied. The singlet character of these emissive σ,π^* CT states was confirmed by picosecond lifetime measurements. The previously reported photochemical rearrangement of (phenylethynyl)pentamethyldisilanes to silacyclopropenes and silapropadienes as well as the observed photochemical cleavage of (phenylethynyl)pentamethyldisilanes to (phenylethynyl)trimethylsilanes are fully consistent with the σ,π^* CT state assignment. The general involvement of analogous $\sigma \rightarrow \pi^*$ CT or electron transfer in photoexcited polysilanes is suggested by the demonstration of intermolecular fluorescence quenching of electron-deficient benzenes and aryl acetylenes by hexamethyldisilane and dodecamethylcycloohexasilane. The general implications of this type of $\sigma \rightarrow \pi^*$ CT to polysilane photophysics and photochemistry are discussed.

28593 Method and apparatus for correcting eddy current signal voltage for temperature effects. Kustra, T.A.; Huntingdon, N.; Caffarel, A.J. To Dept. of Energy, Washington, DC. USA Patent 4893079/A/. 9 Jan 1990. Filed date 29 Aug 1988. USA Patent Application 7-237,203. Int. Cl. G01N 27/72. vp.

This patent describes an apparatus for measuring physical characteristics of an electrically conductive material in a heated environment. It comprises: eddy current probe means including a primary coil and a reference coil for producing an eddy current signal in response to the probe means coming in contact with the material; resistance measuring means including a digital ohm meter for measuring the resistances of the primary coil and the reference coil; output means for outputting the eddy current signal; and switch means connected between the probe means, the resistance measuring means, and the output means, for connecting the probe means to the resistance measuring means to measure the resistances of the coils, and for connecting the probe means to the output means to obtain the eddy current signal.

28594 Electrical method and apparatus for impelling the extruded ejection of high-velocity material jets. Weingart, R.C. To U.S. Dept. of Energy, Washington, DC. USA Patent 4888522/A/. 19 Dec 1989. Filed date 27 Apr 1988. USA Patent Application 7-186,992. Int. Cl. H01J 7/26. vp.

This patent describes an apparatus for producing a high- velocity material jet, the apparatus adapted to be driven by an externally supplied electric current pulse. The apparatus comprising: a coaxial two-conductor transmission line that comprises an outer cylindrical conductor, an inner cylindrical conductor that has a common central axis therewith, and a solid plastic or ceramic insulator that completely fills the space between the inner cylindrical conductor and the outer cylindrical conductor. The transmission line having a first end and a second end. The outer cylindrical conductor and the inner cylindrical conductor at the first end of the transmission line adapted to receive the externally supplied electric current pulse; and a thin-walled metal structure attached or bonded

to the solid plastic or ceramic insulator and conductively joining the outer conductor to the inner conductor at the second end of the transmission line, with the metal structure axisymmetric with respect to the common central axis and having a cavity that opens inwardly toward the interior of the transmission line.

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28595 Characterization and purity determination of trans (±) 1,2-diaminocyclohexane platinum (IV) tetrachloride using liquid chromatography with a platinum selective detector. Urasa, I.T. (Hampton Univ., VA (USA)); Lewis, V.D.; DeZwaan, J.; Northcott, S.E. *Analytical Letters (USA)*, 22(3): 597-619 (Mar 1989).

An important aspect of drug development is the reliable determination of the purity of a bulk drug substance. In the case of Trans ± 1,2-Diaminocyclohexane Platinum (IV) Tetrachloride, classical techniques such as differential scanning calorimetry and phase solubility analysis cannot be used because of the compounds poor thermal and solution stability. In cases of this type, material balance arguments based on chromatographic procedures are currently the only alternative. By using a detector sensitive only to platinum, 2 key assumptions involved in the determination of purity using chromatography can be eliminated. These are: assuming 100% recovery from the column; and equal detector response for all resolved components. The results of this work indicate that a significant variation in extinction coefficients exists among species in solution and that 96.4% of the platinum initially in solutions is in the original form of the compound.

28596 Photochemistry of hydrogen iodide-acetylene complexes in solid krypton. Abrash, S.A. (Lawrence Berkeley Lab., CA (USA)); Pimentel, G.C. *Journal of Physical Chemistry (USA)*, 93(15): 5828-5834 (27 Jul 1989).

Hydrogen iodide-acetylene complexes in a krypton matrix at 12 K have been photolyzed with a medium-pressure mercury lamp. Infrared spectra identify products vinyl iodide and iodoacetylene. When HI x C_2D_2 complexes are photolyzed, isotopic exchange occurs to produce DI x HCCD. Growth curves show that all three are primary products. As well, the growth curves show secondary photolysis of vinyl iodide and DI x HCCD, but apparently production and secondary photolysis of vinyl iodide only catalyze isotopic exchange. The growth curves obtained for HCCI and DCCI from HI x C_2D_2 differ from those obtained from DI x C_2H_2. Short photolysis of HI x C_2D_2 gives almost exclusively HD x DCCI whereas short photolysis of DI x C_2H_2 gives HD x HCCI. Thus, the hydrogen atom in the hydrogen iodide always ends up in the molecular hydrogen product. They conclude that photolytic production of iodoacetylene involves hydrogen atom abstraction from acetylene by the energetic hydrogen iodide.

28597 NMR studies of model hydrodenitrogenation catalysis: Acetonitrile hydrogenation on γ-Mo_2N. Haddix, G.W. (Lawrence Berkeley Lab., CA (USA)); Bell, A.T.; Reimer, J.A. *Journal of Physical Chemistry (USA)*, 93(15): 5859-5865 (27 Jul 1989).

Temperature-programmed reduction of CH_3CN adsorbed on unsupported, high surface area γ-Mo_2N is studied in situ by ^1H and ^{13}C NMR spectroscopy. CH_3CN adsorbs molecules at 298 K, with a fraction of the adsorbate in a highly mobile state. Upon reduction in flowing H_2, some of the adsorbed CH_3CN appears to convert to adsorbed $CH_3CH_xNH_y$. Increased reduction temperature leads to cleavage of the C-N bond, leaving only NH_2 fragments on the catalyst surface.

28598 Semiequilibrium dialysis study of the solubilization of benzoate anion by aqueous hexadecylpyridinium chloride. Mahmoud, F.Z. (Ain Shams Univ., Cairo (Egypt)); Taha, A.A.; Christian, S.D.; Tucker, E.E.; Scamehorn, J.F. *Journal of Physical Chemistry (USA)*, 93(15): 5903-5906 (27 Jul 1989).

Semiequilibrium dialysis (SED) measurements have been used to investigate the solubilization and binding of benzoate anion by micelles of the cationic surfactant hexadecylpyridinium chloride. The equilibrium results are correlated with an ion-binding model described previously, with an additional parameter introduced to account for the solubilization of benzoate at least partly within the micelles. The benzoate ions bind, as expected, as counterions to the positively charged micelles, and in addition, they appear to solubilize similarly to neutral phenols and aromatic carboxylic acids, with the polar group anchored in the head-group region of the micelles and the aromatic moiety extending into the hydrophobic micellar interior.

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Refer also to citation(s) 27561, 27577, 27659, 27668, 27690, 27783, 28149, 28283, 28438, 28439, 28443, 28444, 28499, 28502, 28507, 28509, 28510, 28534, 28569, 28597, 28654, 28790, 28888, 28994, 28995, 29037, 29183, 29224, 29228, 29361, 29597, 29851

28599 (GKSS–87/E/70) **Investigations of fertilizer phosphates for minor and trace elements by means of instrumental neutron activation analysis (INAA).** Schnier, C. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik); Niedergesaess, R.; Heiland, K.; Nagorny, K.; Schnug, E. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1987. 12p. (In German). Available from GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.).

32 raw phosphate samples of different geographical origin were analyzed. No preconcentrations or chemical digestions were needed. After irradiations of 5 minutes and 3 days in the neutron flux of $9x10^{12}$ and $5x10^{13}$ ncm^{-2} s^{-1}, respectively, of the research reactor Geesthacht the following elements could be determined: Na, K, Cl, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Zn, Ga, As, Se, Br, Rb, Sr, Ag, Cd, In, Sn, Sb, J, Cs, Ba, up to 10 Lanthanides, Hf, Ta, W, Os, Hg, Th, U. The detection sensitivity was different for every element. The analyses were complicated not only by the difficult phosphorus matrix but also, in several samples, by high uranium contents. The element concentrations vary enormously according to the origin of the samples. The input of radioactivity to the soils by the elements thorium and uranium is compared to the natural background activity. (orig.).

28600 (INIS-SU–162) **7. All-union conference on physicochemical analysis: Summaries of reports.** AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; AN Kirgizskoj SSR, Frunze (USSR). Inst. Neorganicheskoj i Fizicheskoj Khimii. 1988. 669p. (In Russian). (CONF-8810489–: 7. All-Union conference on physicochemical analysis, Frunze (USSR), 4-6 Oct 1988). Order Number DE90706081. Available from NTIS (US Sales Only), PC A99/MF A01; OSTI; INIS.

Individual papers in scope for the data base are processed separately. (DLC)

28601 (LA–1721-5th-Ed.) **Collected radiochemical and geochemical procedures: Fifth edition.** Kleinberg, J. (comp.). Los Alamos National Lab., NM (USA). May 1990. 310p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90010156. Available from NTIS, PC A14/MF A01 - OSTI; GPO Dep.

This revision of LA-1721, 4th Ed., Collected Radiochemical Procedures, reflects the activities of two groups in the Isotope and Nuclear Chemistry Division of the Los Alamos National Laboratory: INC-11, Nuclear and radiochemistry; and INC-7, Isotope Geochemistry. The procedures fall into five categories: I. Separation of Radionuclides from Uranium, Fission-Product Solutions, and Nuclear Debris; II. Separation of Products from Irradiated Targets; III. Preparation of Samples for Mass Spectrometric Analysis; IV. Dissolution Procedures; and V. Geochemical Procedures. With one exception, the first category of procedures is ordered by the positions of the elements in the Periodic Table, with separate parts on the Representative Elements (the A groups); the d-Transition Elements (the B groups and the Transition Triads); and the Lanthanides (Rare Earths) and Actinides (the 4f- and 5f-Transition Elements). The members of Group IIIB– scandium, yttrium, and lanthanum–are included with the lanthanides, elements they resemble closely in chemistry and with which they occur in nature. The procedures dealing with the isolation of products from irradiated targets are arranged by target element.

28602 (LUTFD2-TFKF–1015-1-139-1989) **European source region identification of long range transported ambient**

aerosol based on PIXE analysis and related techniques. Swietlicki, E. Lund Univ. (Sweden). Dept. of Nuclear Physics. 1989. 127p. Order Number DE90770802. Available from NTIS (US Sales Only), PC A07/MF A01.

An analytical system was developed for the study of long range transported ambient aerosol based on Particle Induced X-ray Emission (PIXE) analysis and related techniques. The system involved the selection of the most suitable projectile and projectile energy and the design of a new, automated chamber. An instrument for the analysis of the fine fraction aerosol mass based on the attenuation of low energy beta radiation was also built and calibrated. Sodium was analysed with Particle Induced Gamma-ray Emission (PIGE) simultaneously with the PIXE analysis at a proton energy of 2.64 MeV. The capability of the analytical system made it possible to establish European source region signatures of the long range transported ambient aerosol, i.e. the composition of the ambient aerosol was shown to be dependent on the origin of the air mass. The separation of the different signatures, as well as the stability of the signatures during transportation within the receptor region defined as southern Sweden were confirmed, using a multivariate statistical approach based on SIMCA and partial least squares regression (PLS). A source region apportionment of the aerosol was performed by discriminant-PLS. Estimates of the emission of several aerosol components within the European source regions were made based on the established source region signatures and previous estimates of the anthropogenic emissions of trace metals in Europe. The multi-sampling station network enabled a study of the transformations taking place during a 400 km transportation across the Baltic Sea. The thesis contains 7 papers. Separate abstracts were prepared for 3 papers.

28603 (LUTFD2-TFKF–1015-1-139-1989, pp. 31-44) **A new PIXE set up dedicated to the analysis of aerosol samples.** Swietlicki, E. (Lund Univ. (Sweden). Dept. of Nuclear Physics); Hansson, H.C.; Loevestam, N.E.G. Lund Univ. (Sweden). Dept. of Nuclear Physics. 1989. In *European source region identification of long range transported ambient aerosol based on PIXE analysis and related techniques.* Order Number DE90770802. Availabie from NTIS (US Sales Only), PC A06/MF A01.

A chamber was designed and built to simplify and expedite the PIXE/PIGE analysis of large number of aerosol samples collected with an automated sampler, extensively used in background aerosol monitoring campaigns. This sampler collects the aerosol automatically on strips of Nuclepore filter membranes, each normally containing fourteen samples and two blanks. Eight such filter strips can be loaded into a revolving magazine in the chamber and analysed in a simultaneous PIXE/PIGE analysis. A ninth filter frame holds a quartz plate for beam inspection and standard samples for quality assurance. The functions of the chamber can be operated both manually or automatically. Normally the elements Na, S, K, Ca, Ti, V, Mn, Fe, Ni, Cu, Zn, Br and Pb can be detected in the fine fraction samples even in continental background air masses. The lowest detection limits (0.07 ng/m^3) are found in the region between Zn and Se. (orig).

28604 (LUTFD2-TFKF–1015-1-139-1989, pp. 47-67) **The design and calibration of a fine fraction aerosol mass monitor based on beta attenuation.** Swietlicki, E. (Lund Univ. (Sweden). Dept. of Nuclear Physics); Svantesson, B.; Hansson, H.C. Lund Univ. (Sweden). Dept. of Nuclear Physics. 1989. In *European source region identification of long range transported ambient aerosol based on PIXE analysis and related techniques.* Order Number DE90770802. Available from NTIS (US Sales Only), PC A06/MF A01.

A fine fraction aerosol bulk mass measuring device based on the attenuation of β radiation with a maximum energy of 66 keV from a 0.2 mCi ^{63}Ni source was developed to fit the filter strips for the fine fraction aerosol stage collected with the SAM (Stationary Aerosol Monitor) sampler. The mass attenuation coefficient for the geometry used was measured to be 1.40 +- 0.04 cm^2/mg, which is about 70 % higher than the value given in the literature. The smallest detectable areal mass density is 3.0 μg/cm^2 at the 1σ level which corresponds to an ambient aerosol mass concentration of about 0.5 μg/m^3. The upper limit for which the exponential decrease for the attenuation of the electron beam intensity is valid is about 700 μg/cm^2. The accuracy and precision of the measurement is estimated to be within 10 % at a typical ambient mass concentration of 10 μg/m^3. Due to particle size effects, the instrument is not suitable for aerosol particle sizes > 2 μm. (orig).

28605 (LUTFD2-TFKF–1015-1-139-1989, pp. 79-117) **European source region identification of long range transported aerosol.** Swietlicki, E. (Lund Univ. (Sweden). Dept. of Nuclear Physics); Hansson, H.C.; Svantesson, B.; Asking, L. Lund Univ. (Sweden). Dept. of Nuclear Physics. 1989. In *European source region identification of long range transported ambient aerosol based on PIXE analysis and related techniques.* Order Number DE90770802. Available from NTIS (US Sales Only), PC A06/MF A01.

A total of 600 fine fraction samples were collected with an automated sampler at three background monitoring stations located on small islands off the south-east of Sweden, and analysed for the mass, elemental carbon (soot), Na, S, K, Ca, Ti, V, Mn, Fe, Ni, Cu, Zn, Br and Pb. From this data base, the long range transported ambient fine fraction aerosol collected in Southern Sweden was characterized according to the origin of the air mass. Several European source regions were significantly separable based on a multivariate statistical analysis, and source region signatures were established. The signature were stable during transportation within the receptor region defined as Southern Sweden. The source region signatures were compared with emission estimates from European anthropogenic sources. The agreement was satisfactory for V, Mn, Ni and Pb but not for but not for Cu and Zn. Based on the emission estimates for Mn and Ni, the emission of several components could be estimated. A source region apportionment based on discriminant-PLS was performed for some well resolved source signatures. (authors).

28606 (NAC-AR–86-01, pp. 211-222) **Nuclear analytical chemistry: Basic studies.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Basic studies in nuclear analytical techniques include the examination of underlying assumptions and the development and extension of techniques involving the use of ion beams for elemental and mass analysis. 8 figs., 1 tab., 11 refs.

28607 (NAC-AR–86-01, pp. 223-224) **Nuclear analytical chemistry: Applications in archaeology.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The identification of the origins of archaeological artefacts is a powerful application of multi-elemental and non-destructive analysis coupled with statistical grouping methods. 1 ref.

28608 (NAC-AR–86-01, pp. 225-226) **Nuclear analytical chemistry: Applications in industry and agriculture.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The Van de Graaff laboratory participated in an international collaboration on the elemental analysis of ecological reference materials. Many nuclear techniques find application in industry and agriculture. Surface activation has been usefully applied to the observation of motor engine wear.

28609 (NAC-AR–86-01, pp. 227) **Nuclear analytical chemistry: Applications of the XSQR technique.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Short note. MULTI-ELEMENT ANALYSIS/x-ray fluorescence analysis; MOLYBDENUM; NAC CYCLOTRON; PIXE ANALYSIS; PROGRESS REPORT; TARGETS

28610 (ORNL/TM–11282) **Advanced techniques for energy-efficient industrial-scale continuous chromatography.** DeCarli, J.P. II (Dow Chemical Co., Midland, MI (USA)); Carta, G.; Byers, C.H. Oak Ridge National Lab., TN (USA). Nov 1989. 201p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE

Contract AC05-84OR21400. Order Number DE90010220. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

Thesis submitted by G. Carta to the Univ. of Virginia, Charlottesville.

Continuous annular chromatography (CAC) is a developing technology that allows truly continuous chromatographic separations. Previous work has demonstrated the utility of this technology for the separation of various materials by isocratic elution on a bench scale. Novel applications and improved operation of the process were studied in this work, demonstrating that CAC is a versatile apparatus which is capable of separations at high throughput. Three specific separation systems were investigated. Pilot-scale separations at high loadings were performed using an industrial sugar mixture as an example of scale-up for isocratic separations. Bench-scale experiments of a low concentration metal ion mixture were performed to demonstrate stepwise elution, a chromatographic technique which decreases dilution and increases sorbent capacity. Finally, the separation of mixtures of amino acids by ion exchange was investigated to demonstrate the use of displacement development on the CAC. This technique, which perhaps has the most potential, when applied to the CAC allowed simultaneous separation and concentration of multicomponent mixtures on a continuous basis. Mathematical models were developed to describe the CAC performance and optimize the operating conditions. For all the systems investigated, the continuous separation performance of the CAC was found to be very nearly the same as the batchwise performance of conventional chromatography. the technology appears, thus, to be very promising for industrial applications. 43 figs., 9 tabs.

28611 (STEV-TB–89-6) **Optic quantification of microorganisms in air and materials samples after separation in polymeric two-phase systems.** Stroem, G. (Swedish Univ. of Agricultural Sciences, Uppsala (SE). Dept. of Forest Products). Statens Energiverk, Stockholm (Sweden). Jun 1989. 23p. (In Swedish). Project STEV-146-250. Order Number DE90770772. Available from NTIS (US Sales Only), PC A03/MF A01.

In order to obtain pure fractions of micro-organisms, free of interference from organic particles, separation in aqueous biphasic systems has been applied for turbidimetric quantification of fungal spores and bacterial cells in extraction liquids from air samples and wooden fuel chip samples. One system seperates organic debris and bacterial cells from fungal spores, while the other system seperates organic particles from fungal spores and bacterial cells. By combining these two systems, the amount of fungal spores and bacterial cells in a material subjected to extraction, can be estimated. The systems showed a high degree of purification (>95%) when extraction liquids from wooden fuel chips were subjected to partition in the two systems. An extractionprocedure increased the separation of bacterial cells and organic particles in the systems, causing an increase of the precision of the analysis. The reproducability of the analysis is very good, both for repeated analysis of the same extraction liquid as well as batch-wise analysis of the same material. Separation experiments of extraction liquids from air samples and wooden fuel chip samples, combined with a turbidimetric detection system, showed a high degree of correlation to direct counting of bacteria and fungi, using epifluorescence microscopy. (4 figs., 5 tabs.).

28612 Application of multilayer structures to the determination of optical constants in the x-ray, soft x-ray and extreme ultra violet spectral ranges. Barbee, T.W., Jr. (Lawrence Livermore National Lab., Livermore, CA (US)). pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

The dispersion of x-rays (XR), soft x-rays (SXR) and extreme ultra-violet (EUV) light by multilayer structures is dependent on the scattering and absorption cross-sections of the elements used to synthesize the multilayer. In this paper it is shown that this dependence provides a means for the accurate experimental determination of the optical constants of the multilayer constituents. Two specific approaches are presented and discussed. It is shown that detailed analysis of the energy dependence of the reflectivity of a simple depth periodic multilayer allows the unfolding of the optical constants. A new optic structure, the multilayer diffraction grating, is described and it is demonstrated that such combined microstructure optics allow the scattering cross-sections of the multilayer constituents to be accurately determined over broad spectral ranges.

28613 X-ray absorption spectroscopic studies of catalystic materials. Via, G.H. (Exxon Research and Engineering Co., Annandale, NJ (US)); Sinfelt, J.H.; Meitzner, G.; Lytle, F.W. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

X-ray absorption spectra (XAS) contain information in the L_{III} near-edge region on filling of the absorber d-band, and in the extended fine-structure region on the physical environment of the absorber. The authors report an evaluation of the effect on platinum L_{III} edges of preparation in clusters with a high fraction of Pt atoms at the surface. They also report the effects on platinum and rhenium L_{III} edges from addition of copper. These effects are surprisingly small. They re-evaluated x-ray absorption fine-structure spectra (EXAFS) of platinum and rhenium in alumina-supported platinum-rhenium bimetallic catalysts.

28614 In situ study of the bonding of impurities in metal-impurity-metal laminate composities. Barrera, E.V. (Dept. of Materials Science and Engineering, Univ. of Pennsylvania, Philadelphia, PA (US)); Heald, S.M.; Marcus, H.L. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J. H. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract AS05-80ER10742. (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

The authors discuss the local structure of interface or near interface impurity elements observed by means of extended x-ray absorption fine structure spetroscopy (EXAFS). Multilayered samples were prepared using reactive ion sputtering, electron beam evaporation, and molecular beam deposition methods with vacuum conditions ranging from 10^{-5} to 10^{-9} Pa. The interface layers of titanium, gallium, and arsenic were deposited in partial to multiple atom layers alternating with 5 to 10 nm thick matrix layers of nickel, cobalt, or aluminum. Oxide phases, atoms in solution, and local ordering were identified. Ti oxide and silicon arsenide were used as standards for the EXAFS analysis. Auger electron spectroscopy complimented the EXAFS analysis.

28615 Use of piezoelectric ceramics in detection and measurement of pulsed laser radiation. Ringwelski, A.Z. (Univ. of Illinois, Chicago (USA)); Beck, K.M.; Gordon, R.J. *Analytical Chemistry (Washington) (USA)*, 61(7): 796-797 (1 Apr 1989). DOE Contract FG05-84ER75155.

In many analytical applications there is a need for a device to measure the energy or spatial profile of a laser pulse. Such a detector is also useful as a trigger for synchronizing various electronic devices with the laser pulse. Pyroelectric detectors, which are frequently used for these purposes, have been reviewed extensively. They have the advantages of high sensitivity, very fast rise times, and broad spectral response. They have the limitation, however, of being fragile devices, subject to damage when exposed to the high laser intensities commonly obtained in the laboratory. In contrast we have found that large piezoelectric ceramics have a much higher damage threshold than pyroelectric crystals, while still maintaining a response time and sensitivity that are suitable for many laboratory applications. In this note we describe the performance of a PZT ceramic detector that is used to measure the output of pulsed CO_2, dye, and excimer lasers.

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Refer also to citation(s) 27424, 27442, 27595, 27839, 27947, 27954, 28114, 28373, 28374, 28375, 28376, 28377, 28378, 28379, 28380, 28381, 28382, 28383, 28384, 28385, 28425, 28436, 28442, 28451, 28452, 28459, 28469, 28470, 28471, 28472, 28474, 28476, 28477, 28478, 28479, 28480, 28481, 28482, 28483, 28484, 28485, 28486, 28503, 28506, 28518, 28534, 28573, 28580, 28581, 28585,

28592, 28595, 28598, 28613, 28679, 28686, 28692, 28790, 29347, 29361, 29364, 29371

28616 (CONF-900395–1, pp. 21-24) **Catalytic hydrogenation of carbon monoxide.** Bell, A.T. (Lawrence Berkeley Lab., CA (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The purpose of this program is to develop an understanding of the fundamental processes involved in catalytic conversion of carbon monoxide and hydrogen to gaseous and liquid fuels. Attention is focused on defining the factors which limit catalyst activity, selectivity, and resistance to poisoning, and the relationship between catalyst composition/structure and performance. To meet these objectives, a variety of surface diagnostic techniques are used to characterize supported and unsupported catalysts before, during, and after reaction. The information thus obtained is combined with detailed studies of reaction kinetics to elucidate reaction mechanisms and the influence of modifications in catalyst composition and/or structure on the elementary reactions involved in carbon monoxide hydrogenation.

28617 (CONF-900395–1, pp. 38-41) **Laser studies of chemical dynamics at the gas - surface interface.** Cavanagh, R.R. (National Institute of Standards and Technology, Gaithersburg, MD (USA)); King, D.S. USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

Dynamics of gas/surface interactions provide the focus for the present experimental program. The primary area of interest involves both the potential and current use of lasers to initiate and control chemical reactions at surfaces. Our studies have been directed towards detailed investigations of molecular desorption induced by pulsed laser radiation. Over the past two years, we have performed quantum-state-specific studies that have clarified the role of excited carrier driven desorption processes in the LID of NO from both metallic $[Pt(111)]^{5-8}$ and semiconductor $[Si(111)]^{9}$ surfaces.

28618 (CONF-900395–1, pp. 42-43) **High pressure heterogeneous catalysis in a low pressure, ultrahigh vacuum environment.** Ceyer, S.T. (Massachusetts Institute of Technology, Cambridge (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The major thrust of their proposed research is to carry out for the first time a heterogeneous catalytic reaction that normally is observed only at high pressures (> 1 atm) of reactant gas at low pressures ($< 10^{-4}$ Torr) in an ultrahigh vacuum environment on a Ni(111) crystal surface. This is possible using a scheme which couples molecular beam techniques with high resolution electron energy loss spectroscopy. Two molecular beams provide a means to activate each of the two reactants and the HREELS is a sensitive and chemically specific detector of the reaction progress. These studies will verify the principles behind the lack of reactivity at low pressures. The ability to carry out a high pressure reaction, such as the steam reforming of CH_4, in a UHV environment enables the use of surface sensitive electron spectroscopies such as HREELS to identify unambiguously the reaction intermediates, thereby testing the mechanisms proposed from high pressure kinetics measurements. With the receipt six months ago of funding for this new project, work has begun on the design of the apparatus.

28619 (CONF-900395–1, pp. 52-55) **Acid/base and redox reactions over oxide catalysts.** Dumesic, J.A. (Univ. of Wisconsin, Madison (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

During the past two years their research funded by the Department of Energy has focused in the following two areas: (i) calorimetric measurements of surface acidity for silica-supported oxides and H-Y zeolites and (ii) temperature programmed reaction studies of the selective reduction of nitric oxide over thin-film vanadia/titania model catalysts. Various aspects of these studies are outlined in the following paragraphs.

28620 (CONF-900395–1, pp. 122-125) **Dynamics of desorption from surfaces.** Janda, K.C. (Univ. of Pittsburgh, PA (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The goal of our DOE sponsored research is to apply the types of laser techniques that have been very effective for characterizing gas phase chemical dynamics to problems associated with molecules interacting with surfaces. Although the dynamics of molecules interacting with surfaces are obviously much more complicated than those of small molecules interacting in the gas phase, we try to choose systems for which the degrees of freedom are separable enough that the concept of motion on a potential energy surface is useful. By measuring product state distributions of the desorption reactions, we will try to specify effective potentials that govern the molecular dynamics.

28621 (CONF-900395–1, pp. 126-129) **Fundamental investigations of supported metal catalysts.** King, T.S. (Ames Lab., IA (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The focus of this investigation is on the relationship between the chemical and structural properties of highly dispersed, supported transition metal catalysts and their catalytic behavior. The goal of these investigations into the nature and behavior of supported bimetallic catalysts is to answer a number of specific, fundamental questions regarding the interactions between constituent metals and how these interactions give rise to catalytic behavior quite different from that of pure metal catalysts.

28622 (CONF-900395–1, pp. 138-140) **Solid state, surface and catalytic studies of oxides.** Kung, H.H. (Northwestern Univ., Evanston, IL (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

High activity and selectivity are often the deciding factors in determining the economic attractiveness of a catalytic process. In catalytic selective oxidation, surface lattice oxygen ions of an oxide catalyst commonly participate directly in the reaction cycle as a reactant. Thus the catalytic activity and selectivity of an oxide depend on its surface properties, and such as surface atomic structure, and rates and extents of reduction and reoxidation, which in turn depend on the corresponding bulk properties. The objectives of this project are to elucidate and understand the interrelationship among surface, bulk and catalytic properties of an oxide.

28623 (CONF-900395–1, pp. 141-144) **Chemical activation of molecules by metals: Experimental studies of electron distributions and bonding.** Lichtenberger, D.L. (Univ. of Arizona, Tucson (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The purpose of this research program is to obtain detailed experimental information on the different fundamental ways metals bond and activate small organic molecules. Information contributing to the development of models for the chemical and physical behavior of molecules bound to metals must come from many sources. Our research is itself a multi-faceted approach. Synthesis and preparations are important for providing specific molecules that are capable of yielding the key spectroscopic information. Theoretical calculations help clarify the developing models in terms of the fundamental principles of electronic structure and bonding, and help guide the directions of the research toward those areas where experimental information is most needed. Our contributions to developing the methods and principles of various electron spectroscopies for the study of transition metal complexes, as discussed below, represent many of the most significant and unique accomplishments of this research. The most direct relationships of this project are clearly with organometallic chemistry, surface science and catalysis.

28624 (CONF-900395–1, pp. 145-148) **A study of catalysts and mechanisms in synthesis reaction.** Lunsford, J.H. (Texas A and M Univ., College Station (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

Surface-generated gas-phase radicals give rise to a phenomenon which is commonly known as heterogeneous-homogeneous catalysis. The objectives of the current research are to determine the factors which influence the formation of hydrocarbon radicals at surfaces, as well as their subsequent reactions on the surface and in the gas phase.

28625 (CONF-900395–1, pp. 149-152) **Structure and reactivity of model thin film catalysts.** Madey, T.E. (Rutgers, The State Univ. of New Jersey, Piscataway (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The purpose of this project is to characterize the structure and reactivity of model bimetallic catalysts, e.g., ultrathin films of Pt and other metals deposited on single crystal surfaces of tungsten. Recent studies have focused on comparisons between the atomically smooth W(110) surface and the atomically rough W(111) surface using several ultrahigh vacuum surface science methods (low energy electron diffraction, LEED, Auger electron spectroscopy, AES, and thermal desorption spectroscopy, TDS). In addition, we have used scanning tunneling microscopy (STM) to provide a microscopic view of Pt induced surface structures with Angstrom level resolutions.

28626 (CONF-900395–1, pp. 153-155) **The dynamics of non-dissociative and dissociative adsorption on Pt(111).** Madix, R.J. (Stanford Univ., CA (USA)); Arumainayagam, C.R.; McMaster, M.C.; Schoofs, G.R. USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The first step in most heterogeneously catalyzed reactions is the adsorption of reactant gases on the surface. Hence a fundamental understanding of catalysis requires the examination of the critical parameters which govern the adsorption process. Such factors include the effects of the incident velocity, angle of incidence, surface temperature, surface coverage, binding energy, shape of the gas-surface interaction potential and changes in internal degrees of freedom. To elucidate such factors, we have investigated several non-dissociative, weakly interacting gas-surface systems. Such systems provide relatively simple cases to understanding fundamental aspects of adsorption phenomena, including physical adsorption which is an important aspect of catalyst characterization.

28627 (CONF-900395–1, pp. 156-159) **Interaction of carbon and sulfur on metal catalysts.** Vajo, J.J. (SRI International, Menlo Park, CA (USA)); Tong, G.T.; Wood, B.J.; McCarty, J.G. USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

During the past two years an investigation of the influence of sulfur chemisorption on the segregation thermodynamics of carbon on Ni(100) was completed. The effect of uniformly sulfur poisoning on Fischer-Tropsch synthesis by iron catalysts and the formation and nature of carbon deposits on ruthenium steam reforming catalysts were also investigated.

28628 (CONF-900395–1, pp. 160-162) **Catalytic chemistry in supercritical media.** Rathke, J.W. (Argonne National Lab., IL (USA)); Klingler, R.J.; Chen, M.J. USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

This research is designed to determine reaction mechanisms and to explore new catalytic chemistry associated with molecular energy resources. An array of real-time high-pressure kinetic and spectroscopic techniques is used to determine the chemistry of small molecules derived from coal, natural gas, and petroleum. Maximal concentrations of reactive gases are achieved by making use of their complete miscibilities with supercritical fluids. Thus, we have recently determined the potential energy profile for activation of hydrogen by the commercial Oxo catalyst in supercritical carbon dioxide solution using high-pressure NMR spectroscopy. In other research, solution-phase oxide catalyzed hydrogenation and water-gas shift processes that seem to parallel metal oxide surface chemistry are explored. Also investigated is the organometallic chemistry of extremely robust metallophthalocyanines designed to achieve stereoselective homogeneous hydrogenation and oxidation catalyses at unusually high temperatures.

28629 (CONF-900395–1, pp. 163-165) **The chemistry and physics of transition metal clusters.** Parks, E.K. (Argonne National Lab., IL (USA)); Jellinek, J.; Knickelbein, M.B.; Riley, S.J. USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

This program is involved in the study of fundamental properties of transition metal clusters, including experimental studies of the chemistry of and on clusters and of cluster photophysics, and theoretical studies of cluster dynamics. Chemical studies include determination of reaction kinetics and mechanism, product composition, and adsorbate thermodynamics. Chemical probes of cluster geometrical structure and ionization potentials have also been developed. Studies of physical properties include threshold photoionization measurements to determine more accurate cluster

ionization potentials. Theoretical effort focuses on dynamical simulations of clusters, including investigation of the effects of rotation on cluster centrifugal distortions, isomerizations, phase transitions, and fragmentation. A major component of the theoretical program is aimed at detailed studies of the dynamics and structure of transition metal clusters.

28630 (CONF-900395–1, pp. 166-169) **Chemical interactions in multimetal/zeolite catalysts.** Sachtler, W.M.H. (Northwestern Univ., Evanston, IL (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

Results of our research under this DOE grant confirm the validity of two basic hypotheses motivating this work; in addition, new concepts have emerged of relevance to the following topics: Formation of mono- or bimetal particles in zeolites by reductive decomposition of volatile metal complexes. Cation-cation interaction as a cause of enhanced reducibility. Modification by Fe ions of zeolite encaged metal clusters.

28631 (CONF-900395–1, pp. 174-177) **Kinetic and spectroscopic characterization of metal oxide and sulfide catalysts.** Schrader, G.L. (Ames Lab., IA (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

Despite the commercial importance of metal oxide and sulfide catalysts, there is a lack of fundamental understanding of the catalytic properties of these materials and the mechanisms of the associated catalytic reactions. In our research a comprehensive approach is used to study the catalytic behavior of these materials including: the development of new catalyst preparation techniques; adsorption experiments to examine the nature of adsorbed species and active sites; and continuous flow/pulse reactor studies to determine kinetic data for mechanistic investigations. Special emphasis is placed in our research program on developing in situ spectroscopic techniques which are capable of examining catalysts under actual operating conditions (such as the elevated temperatures and pressures associated with industrial use). Laser Raman spectroscopy, Fourier transform infrared spectroscopy and NMR spectroscopy are particularly powerful method for examining catalysts under these conditions.

28632 (CONF-900395–1, pp. 178-181) **The effect of catalyst preparation on catalytic activity.** Schwarz, J.A. (Syracuse Univ., NY (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

Supported metal catalysts are commonly prepared by depositing catalytic precursors from aqueous electrolytes onto high surface area oxides. This impregnation step has been the focus of a number of recent studies from our laboratory which seek to relate the effect of formulation procedures on the catalytic properties of supported metal catalyst systems. Although the relationship between preparation variables and catalyst performance may in many cases be obscure, it is the goal of our studies to provide a basis for understanding the first of a series of stages in catalyst preparation: the adsorption process of metallic precursors onto the support surface. Presented here are the summaries of results of studies of three catalyst systems obtained during the period December 1986 to July 1989 under support from DOE Grant DE-FG02-87ER13650. The systems studied were (i) Ru/Al_2O_3 (ii) Ni/Al_2O_3 (iii) Al_2O_3 and TiO_2 supported Pt, Ir and Pt-Ir catalysts.

28633 (CONF-900395–1, pp. 182-185) **Nuclear magnetic resonance in solids.** Slichter, C.P. (Univ. of Illinois, Urbana (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The interests of this group are in fundamental studies of solids and surfaces, principally by magnetic resonance. Included are many-body problems, superconductivity, phase transitions, magnetism, solids which possess unusual properties (such as charge density waves), and electronic, structural, and dynamic aspects of surface atoms and adsorbed molecules. In conjunction with Dr. John Sinfelt of the Exxon Research Laboratories, we are studying surface phenomena of an important class of catalysts, small particles of Pt or other Group VIII transition metals (in which 5% to 75% the metal atoms are on the surface of the particles) supported on alumina. We employ the ^{195}Pt NMR to study how the electronic structure of the surface Pt atoms depends on what atoms (if any) are adsorbed on the surface. By ^{13}C, ^{1}H, $^{2}H_2$ or ^{17}O NMR, we investigate the bonding and structure of adsorbed molecules such as CO, C_2H_2 or C_2H_4. We utilize this knowledge to follow the time dependence of chemical reactions, including the dependence of the rate on temperature. Currently, we are studying high temperature superconductors in both normal and superconducting states. The power of NMR is its ability to pick out specific atoms (e.g. Cu, O, Y) or specific sites (e.g. Cu planes or chains).

28634 (CONF-900395–1, pp. 186-189) **Molecular surface science and its application to heterogeneous catalysis and coatings.** Somorjai, G.A. (Lawrence Berkeley Lab., CA (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

There are two major aims of our studies of surfaces. (1) To determine the atomic surface structure and chemical bonding of metals, adsorbed organic monolayers, oxides and sulfides; (2) to apply this knowledge to understand, on the molecular level, important macroscopic surface phenomena, heterogeneous catalysis and the formation of hard coatings. The experimental techniques most frequently used in these studies include low energy electron diffraction, various electron spectroscopies, the scanning tunneling electron microscope, low pressure plasmas, mass spectroscopy and gas chromatography. We utilize single crystal surfaces in our studies whenever possible.

28635 (CONF-900395–1, pp. 190-193) **Structural and electronic properties of iron and cobalt molecular sieve catalysts.** Suib, S.L. (Univ. of Connecticut, Storrs (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The structure sensitivity of iron and cobalt zeolite catalysts in cyclopropane ring opening, hydrogenation, hydrogenolysis and oligomerization reactions has been the focus of our research program. Small cobalt particles (< 5 angstroms) trapped in NaX zeolite catalyze ring opening reactions, larger (8-10 angstrom) particles catalyze hydrogenation reactions and even large (> 10 angstrom) particles catalyze hydrogenolysis reactions. The smallest particles are 100% dispersed and have been characterized by a variety of methods including chemisorption, ferromagnetic resonance and spin echo nuclear magnetic resonance (SENMR) methods. The unique aspects of this research include the preparation of extremely small particles via microwave discharge

decomposition of organometallic precursors and the characterization of such particles with several complementary techniques, the most promising of which is SENMR.

28636 (CONF-900395–1, pp. 194-197) **Enhancement of activity and selectivity by metal-support interactions.** Vannice, M.A. (Pennsylvania State Univ., University Park (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

This research is focused on two general topics: (1) the utilization of metal-support interactions (MSI) to enhance activity and alter selectivity in hydrogenation reactions involving molecules with both carbonyl bonds and unsaturated C=C bonds, and (2) a better understanding of the chemical state of the support, its influence on the electronic properties of small metal particles, and the nature of the catalytic sites that are present.

28637 (CONF-900395–1, pp. 198-199) **Activation and decomposition of alkanes on group VIII transition metal surfaces: dynamics, kinetics and spectroscopy.** Weinberg, W.H. (Univ. of California, Santa Barbara (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

We have quantified both the trapping-mediated and the direct dissociative chemisorption of ethane on the Ir(110)-(1x2) surface, as well as the trapping-surface. We have also simulated the surface segregation of two reactants into separate islands of the reactants due solely to chemical reaction between the two species (in the absence of any adsorbate-adsorbate interactions), while allowing for variable surface mobilities of the two reactants.

28638 (CONF-900395–1, pp. 118-121) **Theory of the dissociation dynamics of small molecules on metal surfaces: Finite temperature studies.** Jackson, B.E. (Univ. of Massachusetts, Amherst (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

Our goal is to understand the detailed dynamics of molecule-metal interactions, particularly dissociative adsorption. The work is theoretical and makes use of recently developed time dependent quantum scattering techniques. Much of our effort has focused on introducing the effects of finite surface temperature into these calculations.

28639 (CONF-900395–1, pp. 200-203) **Morphological aspects of surface reactions.** White, J.M. (Univ. of Texas, Austin (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. DOE Contract FG05-86ER13626. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

This program involves the preparation and characterization, both structural and kinetic, of a variety of metal-based catalysts and adsorbates thereon. Both model and technically attractive absorbate-substrate systems are being investigated using the tools of catalytic and surface chemical science. The substrates include rhodium and silver as well as combinations of the two. Single crystal, thin film, oxide-bound molecular metal species and oxide-supported particles are included in an integrated program. Oxides of silicon, aluminum and titanium are used to support particles and thin metals films. The morphology and electronic structure of the metals are being characterized by tunneling microscopy and tunneling spectroscopy. Adsorbates include carbon oxides, halogenated hydrocarbons, benzene, and alkalis.

28640 (CONF-900395–1, pp. 204-207) **Theoretical studies of chemisorption and surface reactions on nickel and silicon.** Whitten, J.L. (State Univ. of New York, Stony Brook (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. DOE Contract FG02-84ER45100. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The research is part of a theoretical program on the structure of molecules adsorbed on solid surfaces and dissociative chemisorption with emphasis on transition metal substrates and electronic materials. An embedding theory for treating chemisorption on metals is further developed and applied to the reaction of hydrocarbon fragments and hydrogen coadsorbed on nickel, the dissociation of water on nickel, and the systems H/Ni, NH_3/Ni, and C_6H_6/Ni. The main emphasis of the work is on the energetics of adsorption as a function of surface site, the potential energy for adsorbate motion between surface sites and the energetics of surface reactions. Equilibrium geometries, vibrational frequencies and ionization potentials are also calculated. Studies of π bonding on Si(111) were also completed and work was begun on the Auger ionization of F/Si.

28641 (CONF-900395–1, pp. 208-212) **Vibrational spectroscopic studies of surface chemical interactions in chemisorption and catalysis.** Yates, J.T. Jr. (Univ. of Pittsburgh, PA (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

Modern methods of surface science are being applied to the study of chemisorption and catalysis on both single crystal and high area catalytic surfaces. These areas of research are designed to answer fundamental questions about catalytic chemistry, mixing high resolution studies on single crystals and on real catalysts. In almost all of this work, surface vibrational spectroscopy, applied in four separate ways, is the linking feature of the work.

28642 (DOE/ER/13583–4) **Macrocyclic ligands for uranium complexation: Progress report.** Potts, K.T. Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Chemistry. Apr 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13583. Order Number DE90009958. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Macrocycles with cavity diameters in the region 4.5-5.2 Å, based on computer modeling studies, have been prepared by high dilution cyclocondensation of 2-aminopyridyl substituted biurets and thiobiurets with appropriately substituted, reactive intermediates such as chlorocarbonyl isocyanate and malonyl dichloride. Detailed high field ^1H NMR studies have been used to identify all protons in these macrocycles for structural verification and in confromation studies, and by-products obtained in their synthesis as well as in complexation studies have been characterized and identified using these NMR techniques, as well as single crystal X-ray studies. 5 refs.

28643 (DOE/ER/13879–2) **Reactive characterization as a probe of the nature of catalytic sites: Annual technical progress report, January 1989 to January 1990.** Brenner, A. Wayne State Univ., Detroit, MI (USA). Dept. of Chemistry. 20 Mar 1990. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER13879. Order Number DE90009523. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This program is concerned with achieving a better understanding of the nature of active sites on heterogeneous catalysts. Active sites often account for a very small fraction of a surface. This research program uses a novel approach. The patterns of activities and product distributions of catalysts are used to gain information

on the nature of the active site. Since any reaction product must necessarily channel through the active site, this technique, termed reactive characterization, has the advantage that it is only sensitive to the active site. Further, special emphasis is given to determining the concentration of active sites which enables the activities of homogeneous catalysts, metal oxides, and metals to be compared on the same basis. This report period, the oxides NiOk Cr_2O_3, Co_3O_4, MgO, Fe_2O_3, ZnO, MoO_2, Mn_2O_3, V_2O_3, and CuO have been studied. A unique contribution of this study is that both a lower and upper limit to the number of active sites have been determined. Selective poisoning by CO was used to obtain an upper limit to the number of active sites. The exchange of surface OH groups (σ-OH) with $D_2(g)$ was used to obtain a lower limit to the number of active sites.

28644 (DOE/ER/13880–2) **Late transition metal μ-oxo and μ-imido complexes: Progress report, May 15, 1989–May 14, 1990.** Sharp, P.R. Missouri Univ., Columbia, MO (USA). [1990]. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER13880. Order Number DE90009960. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This project is a study of the synthesis and reactivity of μ-oxo and μ-imido complexes of the second and third series metals of groups 9–11. Our interest in these complexes arises from (1) our desire to model surface species present in catalytic reactions (ethylene epoxidation on Ag, NH_3 oxidation on Pt, NO reduction by CO on Rh, O_2 electroreoduction on Pt^5) and (2) the unique reactivity associated with complexes of "hard" ligands with "soft" metals. This report briefly discusses work in the areas of Rh, Au and Pt complexes. 14 refs.

28645 (DOE/ER/14020–1) **[Experimental and computation studies of polar solvation]: Progress report.** Pennsylvania State Univ., University Park, PA (USA). Dept. of Chemistry. [1990]. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER14020. Order Number DE90009926. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report discusses progress in four areas of the polar solvation studies: solvation dynamics in N-Methyl Amides; Non-Dynamical Time-Dependent Spectral Shifts; Ion Solvation Dynamics; and computer simulations. Also included is the work proposed for the next budget period. 11 refs., 7 figs. (JDL)

28646 (FRCEA-TH–186) **Geochemistry of rare earths in main media of clay formation and sedimentation.** Bonnot-Courtois, C. Paris-11 Univ., 91 - Orsay (France). 1981. 251p. (In French). Order Number DE90773323. Available from NTIS (US Sales Only), PC A12/MF A01.

This work aims (i) at a better knowledge of rare earth behavior in surface conditions and (ii) possible use of rare earth as a marker for argilaceous mineral genesis. Chemical properties of rare earths and geochemistry of these elements in main rocks are recalled. Rare earth behaviour during continental alteration process, experimental hydrolysis of various magmatic materials and rare earth geochemistry in argilaceous minerals in continental shelf are examined. Then some aspects of rare earth behaviour in oceans are studied: alteration of sea bed and hydrothermalism rare earth distribution in pelagic sediments red clays of deep seas and manganese nodules. In conclusion rare earth behaviour in sedimentary processes of the exogenous cycle is summarized.

28647 (OEFZS-A–1570) **Melamine acrylates: An interesting class of oligomers.** Wendrinsky, J. (Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Inst. fuer Chemie); Grienauer, W. Oesterreichisches Forschungszentrum Seibersdorf GmbH (Austria). Nov 1989. 18p. (CH–405/89). Available from the Austrian Research Centre Seibersdorf, A-2444 Seibersdorf (Austria).

Limited Distribution.

Acrylated melamines, a class of radiation curable oligomers, which were considered reactive diluents or impregnating resins, are investigated with regard to their synthesis. It is attempted to attribute the properties and the radiation curing behaviour to the specific synthetic procedure and to the data of the reaction products. Both the molecular mass and the double bond content indicate the formation of more-ring systems. Hexa(methoxymethyl)-melamine and hydroxyalkyl acrylates of a defined quality together with an accurate control of the preparation provide oligomers of a relatively high reactivity resulting in rather hard coatings or impregnations when cured by irradiation. (Author).

28648 (PNL–7281) **GMIN: A computerized chemical equilibrium model using a constrained minimization of the Gibbs free energy.** Felmy, A.R. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 52p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. Order Number DE90010250. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This document is a user's manual and technical reference for the computerized chemical equilibrium model GMIN. GMIN calculates the chemical composition of systems composed of pure solid phases, solid-solution phases, gas phases, adsorbed phases, and the aqueous phase. In the aqueous phase model, the excess solution free energy is modeled by using the equations developed by PITZER and his coworkers, which are valid to high ionic strengths. The Davies equation can also be used. Activity coefficients for non-ideal soild-solution phases are calculated using parameters of polynomial expansion in mole fraction of the excess free energy of mixing. The free energy of adsorbed phase species is described by the triple-layer site-binding model. The mathematical algorithm incorporated into GMIN is based upon a constrained minimization of the Gibbs free energy. This algorithm is numerically stable and reliably converges to a free energy minimum. The data base for GMIN contains all standard chemical potentials and Pitzer ion-interaction parameters necessary to model the system Na-K-Ca-Mg-H-Cl-SO_4-CO_2-$B(OH)_4$-H_20 at 25°C.

28649 (PSI–58) **Use of short-lived isotopes in aerosol science.** Gaeggeler, H.W. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). Paul Scherrer Inst. (PSI), Wuerenlingen (Switzerland). Feb 1990. 9p. Order Number DE90624177. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Invited talk presented at the workshop 'Trends in aerosol science', 4 Dec 1989, Duisburg.

Short-lived isotopes can be applied for investigations of surface interactions with small particles. Advantages of this technique is, first, the extremely low number of atoms which is usually needed for such studies and, second, the possibility to use the short half-lives of the nuclides as a 'clock' for kinetic studies. Morever, the techniques to be presented allow to perform in-situ investigations of physical and chemical processes in a real aerosol. In this paper we shortly describe methods to produce short-lived isotopes in a gas, followed by some applications such as for (i) studies of coagulation rates of single atoms with particles of spherical and fractal shape, (ii) transportation of small particles through capillaries, (iii) environmental aerosol monitoring, and (iv) surface chemistry studies with single atoms. (author) 19 refs., 7 figs.

28650 (SAND–90-0818C) **Chemical reactions during the thermal processing of borazene polymers.** Rye, R.R. (Sandia National Labs., Albuquerque, NM (USA)); Borek, T.T.; Lindquist, D.A.; Paine, R.T. Sandia National Labs., Albuquerque, NM (USA). [1990]. 6p. Sponsored by U.S. DOE Defense Programs; National Science Foundation. DOE Contract AC04-76DP00789. (CONF-900466–4: Spring meeting of the Materials Research Society, San Francisco, CA (USA), 16-21 Apr 1990). Order Number DE90009570. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A class of borazene polymers has been developed which consist of a two-dimensional array of six-membered borazene rings with the borons of adjacent borazene rings separated by -NH- groups. Pyrolysis of these polymers above $\approx$ 1000 C leads to crystalline graphite-like boron nitride (h-BN). The thermal chemistry of thin films of one polymer deposited on KOH etched Al has been examined by thermal decomposition mass spectroscopy (TDMS) and thermal gravimetric analysis (TGA), and the gas evolution chemistry is found to be essentially complete by temperatures of less than 400 C. All products desorb with the same temperature profile and the major desorbing species are NH_3 and N_2 consistent with a loss of excess nitrogen and hydrogen in the polymer, and HCl from decomposition of by-products of the synthesis step. Isotope labeling shows that complete exchange occurs below 400 C between

the ring and amino bridge nitrogens. Since the formation of ordered crystalline h-BN films requires heating to temperatures of the order of 1000 C while the gas evolution and ring opening chemistry is complete by roughly 400 C, it is concluded that gas evolution chemical processes are not rate limiting in BN ceramic production. 17 refs., 3 figs.

28651 (UCRL-JC–103167) **Stability of a pH-sensitive polymer matrix: Applications in fiber optic pH sensors.** Northrup, M.A.; Langry, K.; Angel, S.M. Lawrence Livermore National Lab., CA (USA). Mar 1990. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900140–19: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 15-19 Jan 1990). Order Number DE90009579. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A ratiometric pH-sensitive fluorescent dye (hydroxypyrenetrisulfonic acid) was covalently attached to an acrylamide polymer. These pH-sensitive copolymers were either covalently bonded to the end of an optical fiber or polymerized into separate gels. Long-term, accelerated aging studies were performed on the fibers and gels in 43°C distilled H_2O. The fiber-immobilized optrodes gave good pH responses for up to 2 months. The pH-sensitive gels were physically attached to optical fibers and gave very good pH responses for over one year. These physically immobilized, one-year-old, pH-sensitive copolymers provided optrodes with linear pH responses between pH 6 and 8 and resolution greater than 0.25 pH unit. A simple photostability experiment on these optrodes showed that they were very photostable. The results of this study indicate that pH-sensitive copolymers in a simple optrode design can be employed as pH sensors with useful lifetimes exceeding one year. 11 refs., 6 figs.

28652 **Luminescent tetrametallic complexes of ruthenium.** Murphy, W.R. Jr. (Clemson Univ., SC (USA)); Brewer, K.J.; Gettliffe, G.; Petersen, J.D. *Inorganic Chemistry (USA),* 26(1): 81-84 (11 Jan 1989). DOE Contract FG09-87ER13768.

Tetrametallic complexes constructed around the metal core $Ru(dpp)_3^{2+}$ (where dpp = 2,3-bis(2-pyridyl)pyrazine) have been prepared and characterized. The complexes, which have the general formula $Ru[(dpp)ML_2]_3^{n+}$, where $ML_2 = Ru^{II}(bpy)_2$ (n = 8), $Ru^{II}(phen)_2$ (n = 8), and $Ru^{II}(tpy)Cl$ (n = 5) and bpy = 2,2′-bipyridine, phen = 1,10-phenanthroline, and tpy = 2,2′:6′,2″-terpyridine, are prepared from the reaction of $Ru(dpp)_3^{2+}$ with ML_2Cl_2 in ethanol/water. The tetrametallic complexes luminesce at room temperature in acetonitrile with emissions characteristic of a single ruthenium center with excited-state lifetimes in the 100-ns range. Electrochemically, the most facile reductions occur at the dpp ligand, and the lower energy oxidation is a single peak associated with the three peripheral ruthenium centers. 13 refs., 1 fig., 2 tabs.

28653 **Condensation of monovalent and divalent metal ions on a Langmuir monolayer.** Bloch, J.M. (Exxon Research & Engineering Company, Clinton Township, Route 22 East, Annandale, New Jersey 08801 (USA)— National Synchrotron Light Source, Brookhaven National Laboratory, Building 510E, Upton, New York 11973 (USA)); Yun, W. *Physical Review, A (General Physics) (USA),* 41(2): 844-862 (15 Jan 1990). DOE Contract W-31-109-ENG-38.

A system that consists of a monolayer spread on a solution containing a monovalent and a divalent ion is investigated. The solution of the Poisson-Boltzmann-Stern equation for this system indicates that the metal ions segregating to the surface can be found in two distinct states. Divalent ions are chemically condensed on the monolayer, while monovalent ions are electrically attracted to it. We derive simple expressions for the charge left on the surfactant monolayer and the amount of metal ions condensed on the monolayer. These formulas reproduce very accurately (to within *pro milles*) the values obtained using the nonlinear Grahame equation and eliminate the need to solve that equation. That permits a simple identification of the state of the surfactant monolayer and we propose a universal condensation chart that characterizes the state of the surfactant. We further derive a chemical equilibrium equation for the surface components that has considerable range of validity. This equation requires a knowledge of the bulk concentrations only, and thus allows in many cases the identification of the state of the monolayer, avoiding the need to solve the full nonlinear Poisson-Boltzmann equation. All existing experimental results on Langmuir systems are in good agreement with the one-dimensional Poisson-Boltzmann-Stern model with no adjustable parameters. Several of these fits are presented in this work and are also mapped on the condensation chart. Our calculations point to some characteristic differences between the monovalent and the divalent ions that explain why it is possible to build Langmuir-Blodgett multilayers from divalent compensated surfactants but not from monovalent ones.

28654 **High-temperature sulfidation-regeneration of $CuO-Al_2O_3$ sorbents.** Patrick, V. (California Inst. of Tech., Pasadena, CA (USA). Dept. of Chemical Engineering); Gavalas, G.R.; Flytzani-Stephanopoulos, M.; Jothimurugesan, K. *Industrial and Engineering Chemistry Research (USA),* 28(7): 940-947 (Jul 1989).

Thermogravimetric analysis (TGA) and flow-reactor experiments were used to study sulfidation-regeneration of highly porous $CuO-Al_2O_3$ sorbents. In TGA studies, sulfidation of reduced sorbents produced a high-temperature form of digenite ($Cu_{9+x}S_5$) as the major crystalline product. When a platinum pan was used in the TGA, significant sulfur chemisorption on alumina occurred. Sulfur chemisorption on alumina was eliminated by use of a quartz sample pan. Reaction of the mixed-oxide sorbents with a mixture of H_2S, H_2, H_2O, and N_2 in a packed-bed microreactor, at temperatures between 550 and 800°C, yielded prebreakthrough outlet-H_2S levels considerably lower than those predicted by the sulfidation equilibrium of metallic copper. Independent reduction experiments confirm that alumina stabilizes CuO against complete reduction to Cu. With this mechanism at work, low prebreakthrough H_2S levels are attributed to sulfidation reactions of copper at oxidation states of + 1 or + 2. The sulfided sorbents were completely regenerable in air/N_2 mixtures with no deterioration of subsequent sulfidation performance.

28655 **Experimental studies on the rheology of hard-sphere suspensions near the glass transition.** Marshall, L. (Univ. of Illinois, Urbana (USA)); Zukoski, C.F. IV. *Journal of Physical Chemistry (USA),* 94(3): 1164-1171 (8 Feb 1990). DOE Contract AC02-76ER01198.

We have investigated the rheological behavior of sterically stabilized colloidal silica particles of three different sizes at volume fractions above 0.5. Despite a small surface charge, which elevated the intrinsic viscosity from the Einstein value of 2.5, the particles were found to behave essentially as hard spheres in the concentrated suspensions and to have properties highly reminiscent of molecular glasses. The zero shear rate viscosity, characteristic of disordered suspensions and present at all volume fractions, diverges as $\phi \rightarrow 0.6$ and is well-described by the Doolittle equation for glassy flow. For suspensions with a relative zero shear rate viscosity greater than $5 \times 10_2$, shear thickening was observed. Characteristic time scales for particle rearrangement determined from critical shear rates for shear thinning and shear thickening were found to follow trends predicted for molecular glasses. A transition from a liquid like linear relaxation response to glassy stretched exponential behavior was observed as volume fraction was increased. The onset of the glassy relaxation response, indicative of nondecaying correlations, occurred near a volume fraction of 0.52.

28656 **Adsorbate thermodynamics as a determinant of reaction mechanism: Pentamethylene sulfide on Mo(110).** Wiegand, B.C. (Harvard Univ., Cambridge, MA (USA)); Friend, C.M.; Roberts, J.T. *Langmuir (USA),* 5(6): 1292-1298 (Nov-Dec 1989). DOE Contract FG02-84ER13289.

The reactions of the totally unstrained, six-membered cyclic sulfide pentamethylene sulfide on Mo(110) have been investigated by using temperature-programmed reaction spectroscopy and X-ray photoelectron spectroscopy in an effort to identify the roles of ring size and strain in dictating reaction selectivity. Four gases products are detected in the temperature-programmed reaction of pentamethylene sulfide: dihydrogen at 380 and 590 K, pentane at 350 K, pentene at 345 K, and pentamethylene sulfide at 190 and 280 K. The kinetics for hydrocarbon production from pentamethylene sulfide are qualitatively different than for the four- and five-membered cyclic sulfides, trimethylene sulfide and tetrahydrothiophene.

28657 Hydrogen bonding in carboxylic acid adlayers on Pd(111): Evidence for catemer formation. Davis, J.L. (Univ. of Delaware, Newark (USA)); Barteau, M.A. *Langmuir (USA),* 5(6): 1299-1309 (Nov-Dec 1989). DOE Contract FG02-84ER13290.

The adsorption of acetic acid and propanoic acid was studied on the Pd(111) surface in order to gain insights into the extent of hydrogen bonding present in carboxylic acid adlayers. In the solid phase, acetic acid is known to crystallize in hydrogen-bonded catemers of the form $(CH_3COOH)_n$, while propanoic acid crystallizes as dimers of the form $(CH_3CH_2COOH)_2$. However, on the clean Pd(111) surface both of these adsorbates formed hydrogen-bonded catemers. Acetic acid catemers decomposed near 200 K to produce molecular acetic acid which either desorbed or dissociated to form surface acetates. The observation of catemer formation from both acetic and propanoic acids suggests that adsorbed monolayers may differ from crystalline solids in their hydrogen-bonding characteristics.

28658 Reduced-dimensionality quantum calculations of the thermal rate coefficient for the Cl+HCl→ClH+Cl reaction: Comparison with centrifugal-sudden distorted wave, coupled channel hyperspherical, and experimental results. Sun, Q. (Chemistry Department, Emory University, Atlanta, Georgia 30322 (USA)); Bowman, J.M.; Schatz, G.C.; Sharp, J.R.; Connor, J.N.L. *Journal of Chemical Physics (USA),* 92(3): 1677-1686 (1 Feb 1990). DOE Contract FG05-86ER13568;W-31-109-ENG-38.

Reduced dimensionality (RD) cumulative reaction probabilities (CRPs) are reported for the Cl+HCl→ClH+Cl reaction using two semiempirical extended London–Eyring–Polanyi–Sato potential energy surfaces. Comparison is made with CRPs from centrifugal-sudden distorted wave (CSDW) calculations, and with accurate coupled channel hyperspherical (CCH) CRPs for total angular momentum quantum number J=0. Rotational and bending energy-shift approximations are applied to the CCH CRPs for J=0 to obtain approximate CRPs for J>0. A test of this approximation is made using CSDW partial wave CRPs. New expressions for the thermal rate coefficient are derived using these approximations. The rate coefficients calculated from RD and energy-shifted CCH CRPs are in excellent agreement with each other. They also agree well with the CSDW and experimental rate coefficients.

28659 Reactions of intermetallic clusters. Farley, R.W. (Department of Chemistry, Pennsylvania State University, University Park, Pennsylvania 16802 (US)); Castleman, A.W. Jr. *Journal of Chemical Physics (USA),* 92(3): 1790-1795 (1 Feb 1990). DOE Contract FG02-88ER60648.

Reaction of bismuth–alkali clusters with closed-shell HX acids provides insight into the structures, formation, and stabilities of these intermetallic species. HCl and HI are observed to quantitatively strip Bi_xNa_y and Bi_xK_y, respectively, of their alkali component, leaving bare bismuth clusters as the only bismuth-containing species detected. Product bismuth clusters exhibit the same distribution observed when pure bismuth is evaporated in the source. Though evaporated simultaneously from the same crucible, this suggests alkali atoms condense onto existing bismuth clusters and have negligible effect on their formation and consequent distribution. The indistinguishibility of reacted and pure bismuth cluster distributions further argues against the simple replacement of alkali atoms with hydrogen in these reactions. This is considered further evidence that the alkali atoms are external to the stable bismuth Zintl anionic structures. Reactivities of Bi_xNa_y clusters with HCl are estimated to lie between 3×10^{-13} for Bi_4Na, to greater than 4×10^{-11} for clusters possessing large numbers of alkali atoms. Bare bismuth clusters are observed in separate experiments to react significantly more slowly with rates of $1–9\times10^{-14}$ and exhibit little variation of reactivity with size. The bismuth clusters may thus be considered a relatively inert substrate upon which the alkali overlayer reacts.

28660 Photoionization studies of GeH_n (n=2–4). Ruscic, B. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)); Schwarz, M.; Berkowitz, J. *Journal of Chemical Physics (USA),* 92(3): 1865-1875 (1 Feb 1990). DOE Contract W-31-109-ENG-38.

The adiabatic ionization potential of GeH^+_4 (GeH_4) is measured by photoionization mass spectrometry to be $\leq$10.53 eV and perhaps as low as 10.44 eV. This is about 0.8 eV (~9 vibrational quanta) lower than the value reported by photoelectron spectroscopy. This result, analogous to that found for SiH^+_4 (SiH_4), implies a marked Jahn–Teller distortion of GeH^+_4. The appearance potentials of GeH^+_2 and GeH^+_3 from GeH_4 are $\leq10.77_2\pm0.009$ eV and $<11.65_7\pm0.01$ eV, respectively. The reaction of F atoms with GeH_4 generates GeH_3, GeH_2 (weakly), and some atomic germanium. The adiabatic ionization potential of GeH_3 is $\leq7.94_8\pm0.005$ eV; that of GeH_2 is $\leq$9.25 eV. Together with auxiliary information, limits (more probable values) of the incremental bond energies, in kcal/mol, are found to be D_0 ($H_3Ge–H$) <85.5 (82±2); D_0 ($H_2Ge–H$) >56.4 (59); D_0 (HGe–H) <68.9 (66); and D_0 (Ge–H) >53.7 (63). These specific bond energies, when appropriately normalized, display the same pattern as the SiH_n (but not the CH_n) bond energies and provide a basis for estimating the corresponding SnH_n bond energies.

28661 Theoretical study of GeH_n, AsH_n, and SeH_n: Bond dissociation energies. Binning, R.C. Jr. (Department of Chemistry and Physics, Carlow College, Pittsburgh, Pennsylvania 15213 (USA)); Curtiss, L.A. *Journal of Chemical Physics (USA),* 92(3): 1860-1864 (1 Feb 1990). DOE Contract W-31-109-ENG-38.

Ab initio molecular orbital theory (Moller–Plesset perturbation theory to fourth order and new basis sets developed for Ge, As, and Se) is used to calculate the atomization energies of GeH_n(n=1–4), AsH_n(n=1–3), and SeH_n(n=1–2). Good agreement is found with the experimental bond dissociation energies of these hydrides derived from recent photoionization studies. The theoretical energies are combined with experimental data on the isolated atoms to determine ideal enthalpies of formation at 0 K for these hydrides, which are expected to have an accuracy of about ±3 kcal/mol (±0.15 eV).

28662 Ligand-centered oxidation of manganese(II) complexes. Richert, S.A. (Texas A and M Univ., College Station (USA)); Tsang, P.K.S.; Sawyer, D.T. *Inorganic Chemistry (USA),* 26(10): 1814-1818 (18 May 1988). DOE Contract AS05-80ER10742.

The oxidation potentials for an extensive group of manganese(II) complexes and their zinc(II) analogues have been determined by cyclic voltammetry in acetonitrile. With the exception of the pyridine, pyridine N-oxide, and H_2O ligands, the oxidations of the manganese(II) complexes occur at substantially less positive potentials than those for the zinc(II) analogous and clearly are ligand-centered. The removal of an electron from the valence shell of the ligand is easier than removal from the d^5 manifold of manganese(II) and is facilitated by formation of a manganese (d-electron)-ligand (p-electron) covalent bond. The negative shift in potential for ligand oxidation is proportional to the bond energy. The near-edge x-ray absorption energies for the oxidized and reduced forms of the manganese complexes have been determined and correlated with the electrochemical results. The edge energy for manganese(II) is 6546.0 ± 0.3 eV, for manganese(II), 6550 ± 0.5 eV, and for the manganese(II) covalently bonded to an oxidized ligand, 6548.3 ± 0.5 eV. A manganese(II/III) valence change has a shift of a 4.0 eV, and the formation of a manganese(II)-(•L) covalent bond from a ligand-centered oxidation has an average shift of 2.3 eV per bond formed. Formulation of MnO_4^- as $Mn^{II}(•O•)(•O^-)_3^-$ with five Mn-O covalent bonds leads to a predicted edge energy of 6557.5 eV; the observed value is 6556.5 eV.

28663 Time dependence of trapping and detrapping of particles by saturable traps. Richards, P.M. (Sandia National Laboratories, Albuquerque, New Mexico 87185-5800 (US)). *Journal of Chemical Physics (USA),* 92(3): 1963-1971 (1 Feb 1990). DOE Contract AC04-76DP00789.

The rate for trapping and detrapping of particles diffusing to saturable traps is investigated. Careful attention is paid to the fact that, for traps which can hold only one particle, the trap occupation p_T must be regarded as a stochastic rather than continuous variable. It is shown that neglecting correlation between p_T and the occupation p_1 of particles in the trap's neighborhood can lead to serious errors when the reaction is diffusion limited. However, an average correlation (AC) approximation, which is justified on the basis of detailed consideration of the hopping equations, is shown

to be reliable in all cases. The AC is further shown to be equivalent to the McNabb–Foster equations, previously derived by heuristic arguments only, in the continuum limit. Short time effects are predicted in the diffusion-limited regime which result from the discreteness of the lattice. Results of the theory are supported by good agreement with Monte Carlo simulation data.

28664 Reaction at traps involving two diffusing species: Application to atomic–molecular hydrogen conversion at defects. Richards, P.M. (Sandia National Laboratories, Albuquerque, New Mexico 87185-5800 (US)); Myers, S.M. *Journal of Chemical Physics (USA),* 92(3): 1972-1979 (1 Feb 1990). DOE Contract AC04-76DP00789.

Kinetics of diffusion-limited reactions are derived for the case in which there are two mobile species *A* and *M* which can convert to one another at a trap or catalysis site. At the same time the standard reaction of *A* getting trapped and detrapped is allowed to compete with the $A \rightleftarrows M$ reaction. Nonlinearities associated with trap saturation and the model where *M* is a diatomic molecule of *A* are included. Rate equations are derived for the bulk concentrations of *A* and *M*. Excellent agreement is obtained with simulation data when account is taken of the correlation between trap occupation and concentration immediately outside the trap. The equations are specifically designed for trapping, recombination, and dissociation of hydrogen atoms and molecules at defects; but they should have a broad range of applicability so that problems with several species and reactions can be handled with the same degree of accuracy as the Smoluchowski theory for trapping and detrapping of a single species. Results are accurate and general enough to include the nonlinearities introduced by trap saturation and trap-concentration-dependent rate constants.

28665 Structural steps to oxidation of Ni(100). Wang, W. (Department of Chemistry, Ames Laboratory, Iowa State University, Ames, Iowa 50011 (US)); Wu, N.J.; Thiel, P.A. *Journal of Chemical Physics (USA),* 92(3): 2025-2035 (1 Feb 1990). DOE Contract W-7405-ENG-82.

In this paper, we emphasize the temperature- and exposure-dependent development of low-energy electron diffraction patterns,measured quantitatively during oxidation of Ni(100) at 80 to 400 K. We find a strong temperature dependence in the development of LEED patterns associated with NiO. NiO(111) is favored by adsorption temperatures below 300 K, whereas a (7×7)-like structure is favored by adsorption temperatures of 300 to 400 K. Room temperature is a "crossover" point between these two forms of the oxide. The final oxide depth is independent of adsorption temperature and, therefore, of epitaxial orientation, between 80 and 400 K. When the sample is heated in vacuum after adsorption, massive rearrangements take place above 500 K. Some of the nickel reverts to metallic nickel covered by a $c(2\times2)$ oxygen overlayer, and some forms NiO crystallites which are probably deeper than the initial oxide skin. Effectively, the parent oxide disproportionates into a less-oxygen-rich phase and a more-oxygen-rich phase. This is again independent of the orientation of the initial oxide epitaxy.

28666 Method-dependent diffusion coefficients on interactive systems. Tringides, M.C. (Ames Laboratory and Department of Physics, Iowa State University, Ames, Iowa 50011 (US)). *Journal of Chemical Physics (USA),* 92(3): 2077-2082 (1 Feb 1990).

Diffusion coefficients are examined in interactive models by using different methods and different overlayer configurations. Comparison between the fluctuation and laser-induced-desorption method on well-equilibrated overlayers can lead to large differences depending on the ordered structures formed. If comparison is made between well-equilibrated and faraway-from-equilibrium configurations different diffusion coefficients and activation energies are obtained. Finally, the activation energy ΔE_c obtained from growth rates in coarsening experiments is shown to verify $\Delta E_c = x\Delta E_d$, where x is the growth exponent and ΔE_d the activation energy of diffusion.

28667 Magic numbers through chemistry: Evidence for icosahedral structure of hydrogenated cobalt clusters. Klots, T.D. (Chemistry Division, Argonne National Laboratory, Argonne, IL 60439 (US)); Winter, B.J.; Parks, E.K.; Riley, S.J. *Journal of Chemical Physics (USA),* 92(3): 2110-2111 (1 Feb 1990). DOE Contract W-31-109-ENG-38.

The equilibrium adsorption of H_2O on hydrogenated cobalt clusters is used to estimate the cluster–H_2O binding energy. Magic numbers, corresponding to clusters with enhanced binding energy, are found for clusters having one more metal atom than closed shells or subshells of the third Mackay icosahedron. It is argued that a lone metal atom outside a closed (sub)shell should have enhanced ability to bind H_2O, and that such chemical probes can be used to provide useful information about metal cluster structure.

28668 Ferromagnetic behavior in linear charge-transfer complexes. Structural and magnetic characterization of octamethylferrocene salts: $[Fe(C_5Me_4H)_2]^{\bullet+}[A]^{\bullet-}$ (A = TCNE, TCNQ). Miller, J.S. (E.I. de Pont de Nemours and Co., Inc., Wilmington, DE (USA)); Glatzhofer, D.T.; O'Hare, D.M.; Reiff, W.M.; Chakraborty, A.; Epstein, A.J. *Inorganic Chemistry (USA),* 28(15): 2930-2939 (26 Jul 1989).

The reaction of $Fe^{II}(\eta^5\text{-}C_5Me_4H)_2$ with cyano acceptors A [A = TCNE (tetracyanoethylene), TCNQ (7,7,8,8-tetracyano-p-quanodimethane), n-$C_4(CN)_6$ (n-hexacyanobutadiene), $C_6(CN)_6$ [tris(dicyanomethylene)cyclopropane], DDQ (2,3-dichloro-5,6-dicyanobenzoquinone), $TCNQF_4$ (perfluoro-7,7,8,8-tetracyano-p-quinodimethane) results in formation of 1:1 charge-transfer salts of $[Fe^{III}](C_5Me_4H)_2]^{\bullet+}[A]^{\bullet-}$ composition. The TCNE and TCNQ complexes have been structurally characterized. The high-temperature magnetic susceptibility for polycrystalline samples of these complexes can be fit by the Curie-Qeiss law, $\chi = C(T\text{-}\theta)^{-1}$, with $\theta = +0.5 \pm 2.2$ K, and μ_{eff} ranges from 2.71 to 3.97 μ_B, suggesting that the polycrystalline samples measured had varying degrees of orientation. The 7.0 K EPR spectrum of the radical cation exhibits an axially symmetric powder pattern with $g_{\parallel} = 4.11$ and $g_{\perp} = 1.42$, and the EPR parameters are essentially identical with those reported for ferrocenium and decamethylferrocenium. No EPR spectrum is observed at 78 K. Akin to the $[Fe(C_5Me_5)_2]^{\bullet+}$ salts, these salts have ^{57}Fe Moessbauer spectra consistent with complete charge transfer; however, unlike the case for the former complexes, quadrupole splittings of 0.30 and 0.220 mm/s are observed at 4.8 and 298 K, respectively. The absence of strong interionic magnetic coupling for the $[Fe(C_5Me_4H)_2]^{\bullet+}$ salts contrasts with the behavior of the $[Fe(C_5Me_5)_2]^{\bullet+}$ salts. 26 refs., 13 figs., 8 tabs.

28669 Energy factors governing the partial irreversibility of lithium intercalation in layered trichalcogenides MX_3 (M = Ti, Zr, Hf; X = S, Se) and the structural changes in the intercalated species Li_3MX_3. Canadell, E. (Universite de Paris, Orsay (France)); Thieffry, C.; Mathey, Y.; Whangbo, Myung-Hwan. *Inorganic Chemistry (USA),* 28(15): 3043-3047 (26 Jul 1989).

The two-step mechanism proposed to explain the results of electrochemical intercalation of layered trichalcogenides MX_3 (M = Ti, Zr, Hf; X = S, Se) cannot explain the results of chemical intercalation. Thus, we propose a one-step mechanism for chemical intercalation in which each metal of MX_3 is affected by three lithium atoms at a time and analyze the merits of the one- and two-step mechanisms. State correlation diagrams show that the one- and two-step mechanisms are symmetry-allowed and symmetry-forbidden, respectively. This conclusion is supported by tight-binding band electronic structure calculations on the model ZrS_5 chain. The cell parameter changes from a, b, and c in MX_3 to approximately 2a + 1, b, and c + 0.3 in Li_3MX_3 are explained by considering how the X-X bond breaking affects the interchain X...X and M...X interactions. 21 refs., 7 figs.

28670 Mean-field models for molecular states and dynamics: New developments. Gerber, R.B. (Hebrew Univ. of Jerusalem (Israel)); Ratner, M.A. *Journal of Physical Chemistry (USA),* 92(11): 3252-3260 (2 Jun 1988).

For accurate description of vibration/rotation eigenstates of molecules, and for discussion of reactions and relaxation processes, simple independent-mode pictures are generally inadequate. Mean-field methods, in which each mode acts subject to a mean potential (static or dynamic) that is just the exact potential averaged over all other modes of the system, are attractive for treating such problems for several reasons: they are conceptually

simple, numerically tractable, quantitatively quite accurate, and generally applicable to a wide variety of molecular species, energies, and coupling conditions. For these reasons, such mean-field, or self-consistent-field, techniques have been applied to molecular problems quite extensively within the last decade. We discuss several aspects of recent and current work on mean-field applications to molecular problems. In the class of static mean-field, or self-consistent-field, methods such situations include inversion of vibration/rotation spectra to obtain potential energy surfaces, distorted-wave Born approximation work on vibrational predissociation lifetimes of long-lived van der Waals complexes, and an extension of the Slater theory for unimolecular decay rates in the weak-coupling regime. Applications of time-dependent SCF, or TD-SCF, include a linearized approximation for investigation of long-time processes and study of the Fourier representation to derive random-phase approximations for direct calculation both of excitation energies and of instabilities and lifetimes. Several intriguing problems remain in the general area of mean-field methods for molecular systems: these include optimal choice of coordinate systems, selection of initial state in dynamical problems, and methods for tractable extension of mean-field approximations.

28671 Formation and decay of zinc tetrakis(N-methyl-4-pyridinio)porphyrin π-radical cation in aqueous solutions containing azide ions and a polyelectrolyte. Nahor, G.S. (National Bureau of Standards, Gaithersburg, MD (USA)). *Journal of Physical Chemistry (USA)*, 92(15): 4359-4366 (28 Jul 1988). DOE Contract AI05-83ER13108.

The formation and decay of the π-radical cation of zinc tetrakis(N-methyl-4-pyridinio)porphyrin ($ZnTMPyP^{4+}$) were studied by using the pulse radiolysis technique. The radical cation ($ZnTMPyP^{5+}$) was produced in N_2O-saturated, aqueous solutions containing azide ions. Its formation and decay kinetics were monitored by following its absorbance at 700 nm. The formation kinetics and the initial absorbance were found to depend on both $ZnTMPyP^{4+}$ and azide concentrations. The decay kinetics were second order with respect to [$ZnTMPyP^{5+}$] and depended on (N_3^-), [$ZnTMPyP^{4+}$], and the ionic strength. The results are explained by multicomplexation of $ZnTMPyP^{5+}$ with azide and by a decay via an equilibrium process involving the $ZnTMPyP^{5+}/N_3^-$ complexes, $ZnTMPyP^{4+}$, and the dication $ZnTMPyP^{6+}$. When a negatively charged polyelectrolyte, poly(styrenesulfonate) (PSS), was added, a decrease in the rate of the $ZnTMPyP^{5+}$ formation was observed as well as a decrease in the initial absorbance. These results are related to the binding of the porphyrin to the oppositely charged polyelectrolyte. A slight increase in the decay rate was also observed, which was interpreted by dynamics of the binding polyelectrolyte. A slight increase in the decay rate was also observed, which was interpreted by dynamics of the binding process, or aggregation. Optimal conditions are suggested for utilization of $ZnTMPyP^{4+}$ in the photooxidation of water.

28672 Reference electrode for strong oxidizing acid solution. Rigdon, L.P.; Harrar, J.E.; Bullock, J.C.; McGuire, R.R. To U.S. Dept. of Energy, Washington, DC. USA Patent 4891124/A/. 2 Jan 1990. Filed date 23 May 1989. USA Patent Application 7-355,523. Int. Cl. G01N 27/26. vp.

This patent describes a reference electrode suitable for long-term, reproducible measurement of the oxidation-reduction potential (ORP) of strong oxidizing acid solution. It comprises: a half cell of metal/Ce(IV)/Ce(III)/mineral acid solution.

4004 Electrochemistry

Refer also to citation(s) 28113, 28115, 28222, 28452, 28453, 28522, 28555, 28591

28673 Surface electrochemistry. Hubbard, A.T. (Univ. of Cincinnati, OH (USA)). *Langmuir (USA)*, 6(1): 97-105 (Jan 1990).

Surface electrochemistry studies are described in which molecular layers formed at Pt(111) surfaces in electrolyte solutions are characterized by surface spectroscopy and voltammetric methods. Types of compounds studied thus far include alcohols, aldehydes, alkenes, alkynes, amides, amines, amino acids, aromatic compounds, electrodeposited metals (Ag, Cu, Bi, Pb, Tl), halides, cyanide, thiocyanate, mercaptans, nitriles, and others. Chemisorbed species are in most cases not removed from Pt by rinsing. Cyclic voltammetry of reversibly electroactive adsorbates before and after evacuation has revealed that chemisorbed layers formed in solution are stable also in vacuum, permitting identification and quantitation by Auger spectroscopy, EELS, LEED, and related methods. Elemental composition and molecular packing density of adsorbed molecular layers are reliably measured by means of Auger spectroscopy, provided that beam currents are kept sufficiently small and the apparatus is directly calibrated.

4005 Photochemistry

Refer also to citation(s) 28426, 28596

28674 (DOE/ER/13439-5) **Infrared absorption spectroscopy and chemical kinetics of free radicals.** Curl, R.F.; Glass, G.P. Rice Univ., Houston, TX (USA). Mar 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-85ER13439. Order Number DE90009469. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Research on reactions of free radicals continued. Progress is briefly described in the following areas: (1) pressure effects in reactions of C_2H with CO and C_2H_6: rate constants; (2) NO HNO produced in the thermal $DeNO_x$ process; and (3) product branching ratios for NH_2 and NO between 300K and 1200K. 2 figs. (CBS)

28675 Molecular phosphorescence enhancement via tunneling through proton-transfer potentials. Gormin, D. (Florida State Univ., Tallahassee (USA)); Heldt, J.; Kasha, M. *Journal of Physical Chemistry (USA)*, 94(3): 1185-1189 (8 Feb 1990). DOE Contract FG05-87ER60517.

A set of four substituted aminosalicylates, whose respective structures permit normal fluorescence, twisted intramolecular charge-transfer fluorescence, and proton-transfer fluorescence, in various combinations, were studied at 77 K to observe the effect on intersystem crossing. It is shown that the molecular structures which are capable of intramolecular proton transfer exhibit greatly enhanced normal molecule phosphorescence. The excitation mechanism involves proton-tunneling $S_1 \rightarrow S_1'(PT)$ after primary excitation, enhanced intersystem crossing from the tautomer excited state $S_1'(PT) \rightarrow T_1'(PT)$, followed by reverse proton-transfer tunneling via triplet potential $T_1'(PT) \rightarrow T_1$. The competitive singlet-state excitation processes are delineated by picosecond transient absorption spectrometry. The mechanism described requires the specific electronic state energy ordering $S_O < S_O' < T_1 < T_1' < S_1' < S_1 \cdots$ where the primes represent the states of the tautomer form of the molecule.

28676 Cage escape yields from the quenching of $Ru(bpy)_3^{2+}$ by methylviologen in aqueous solution. Hoffman, M.Z. (Boston Univ., MA (USA)). *Journal of Physical Chemistry (USA)*, 92(12): 3458-3464 (16 Jun 1988).

The primary quantum yield of formation of $Ru(bpy)_3^{3+}$ and methylviologen radical cation ($MV^{+\cdot}$), ϕ, resulting from the oxidative quenching of $Ru(bpy)_3^{2+}$ by methylviologen (MV^{2+}) in aqueous solution, has been determined by the use of pulsed-laser flash photolysis (λ_{exc} = 532 nm; λ_{mon} = 450 nm) as a function of [MV^{2+}], ionic strength, and pH in the absence and presence of Na_2SO_4, $C_2O_4^{2-}$ (Na^+ or K^+ salt), and ethylenediaminetetraacetate (EDTA). Inasmuch as $\phi = \eta_q \eta_{ce}$, where η_q is the efficiency of the quenching of $Ru(bpy)_3^{2+}$ ($=k_q MV^{2+}/(k_0 + k_q[MV^{2+}])$) and η_{ce} is the cage escape efficiency of the germinate redox pair, values of η_{ce} are easily calculated. The values of η_{ce} are a complex function of the solution medium parameters, reflecting the self-aggregation of MV^{2+}, the presence of ion-pair aggregates of MV^{2+} and EDTA, and the effect of the ionic strength of the solution on the rate constant of the cage escape reaction. Values range from ≈ 0.45 in the limit of zero ionic strength at [MV^{2+}] ≥ 5 mM to ≈ 0.10 at high ionic strength (3.0 M) in the presence of Na_2SO_4 and $C_2O_4^{2-}$; η_{ce} followed an empirical relationship as a function of μ: $\eta_{ce} = (2.22 + 3.81\ \mu^{\frac{1}{2}})^{-1}$. For solutions containing 0.010-0.10 M EDTA, η_{ce} is generally lower than that predicted by the empirical relationship, indicating the existence of a specific effect for that reagent due, perhaps, to the presence of ion-paired aggregated of MV^{2+} and

EDTA. The results obtained here compare very well with values of γ_{ice} reported by other investigators.

4006 Radiation Chemistry

Refer also to citation(s) 27663, 28574, 28584, 28647, 28892, 29175, 29852

28677 (BNL–52229) **Report of the workshop on the proposed pulse radiolysis facility at Brookhaven National Laboratory, September 8th and 9th, 1989.** Brookhaven National Lab., Upton, NY (USA). [1989]. 77p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-8909316–Summ.: Workshop on the proposed pulse radiolysis facility, Upton, NY (USA), 8-9 Sep 1989). Order Number DE90007941. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The Brookhaven National Laboratory Chemistry Department is considering making a request to the Department of Energy for a linear accelerator for radiation chemical studies. The machine being considered is based on a radio-frequency resonant cavity electron gun with a laser-drive photocathode source, similar to the 5 MeV gun developed at the Brookhaven Accelerator Test Facility. The laser can be synchronized with the rf to produce a single bunch of electrons (about 30 ps) containing about 20 nanocoulombs. Shorter pulses can be generated at correspondingly small doses. A laser pulse extending over several rf wavelengths can be used to produce longer and more intense electron pulses. This device offers the possibility of an economical machine with the added advantage of a synchronized electron beam and laser beam which can be used for analysis at sub-nanosecond times. A workshop was held at Brookhaven in the Chemistry Department on September 8 and 9, 1989, to determine how much outside user interest there is in such a machine and what support equipment the users would need. About 30 people attended the conference–some from laboratories with pulse radiolysis facilities and other who might be interested in using the new facility. The capabilities of the major existing facilities and a few others in the Eastern US were discussed in detail and are presented.

28678 (ISH–130) **Thermoluminescence and chemiluminescence measurements for detection of radiation treatment of spices: A European interlaboratory comparison.** Heide, L. (Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene); Guggenberger, R.; Spiegelberg, A.; Boegl, K.W.; Ammon, J.; Beczner, J.; Delincee, H.; Demmer, D.; Schilling, M. Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene. Apr 1989. 259p. (In German). Available from Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene.

In cooperation with 6 institutions responsible for food control and 5 research groups from 5 European countries the Federal Health Office (BGA) organized a collaborative study for identification of irradiated spices and dried vegetables. The objective was to proof whether the methods of CL and TL measurements, which had been developed at the Institute for Radiation Hygiene, are suitable for identification. To get an information about the reliability of the identification of irradiated samples, the threshold values of the BGA reference sample set should be used for classification of the samples, but multiplied by a factor 2, 3 or 4. The more the threshold value is exceeded by the measuring value of an unknown sample the more certain is the judgement that the corresponding sample had been irradiated. The results of the TL measurements can be summarized as follows. Operating with a factor 2, all 495 samples had been identified correctly. When calculated with a factor 3, all samples except one irradiated sample of mushrooms had been identified correctly. The results of the CL analysis have shown that a factor > 2 must be used when assigning the samples, otherwise some of the unirradiated samples will also be declared as irradiated. Considering a factor 3 for better reliability and the standard deviation of the measuring values, false positive results can be excluded. In total 148 out of 228 irradiated samples (65%) were identified. (orig./MG).

28679 **Influence of fractal geometry on geminate escape probability, mean recombination time, and homogeneous reaction rate.** Mozumder, A. (Department of Chemistry—Radiation Laboratory, University of Notre Dame, Notre Dame, Indiana 46556 (USA)). *Journal of Chemical Physics (USA)*, 92(2): 1015-1020 (15 Jan 1990).

The effects of fractal geometry on the geminate escape probability, the mean recombination time, and the homogeneous reaction rate have been evaluated for both neutral and ionic recombinations. Following Lopez-Quintella *et al.* [J. Chem. Phys. **88**, 7478 (1988)] the fractal geometry effect is exhibited through a position-dependent diffusion coefficient. In general, the mean recombination time increases with the mean free path, even more significantly when the latter is comparable with the reaction radius or greater. The escape probability increases with the mean free path for nearly diffusion-controlled reactions but decreases with it for reactions that are governed by energy-loss considerations. The homogeneous ionic recombination rate decreases with the mean free path, in approximate agreement with the Monte Carlo results of Tachiya [J. Chem. Phys. **87**, 4108 (1987)] if the scale parameter is taken to be 3.7 times the mean free path.

28680 **Chemistry and radiation effects of thorite-group minerals from the harding pegmatite, Taos County, New Mexico.** Lumpkin, G.R. (Univ. of New Mexico, Albuquerque (USA)); Chakoumakos, B.C. *American Mineralogist (USA)*, 73(11-12): 1405-1419 (Nov-Dec 1988).

Dark brown and yellow thorites, with compositions extending the range of natural solid solution for the zircon structure type, occur as 0.5- to 2-cm grains in the quartz zone, cleavelandite unit (replacing the beryl zone), quartz-lath spodumene zone, and microcline-spodumene zone of the Harding pegmatite, Taos County, New Mexico. Electron-micro-probe analyses (wt%) give the following for thorites from the cleavelandite unit: 2.9-19.6 P_2O_5, 6.4-16.5 V_2O_5, 0.2-1.2 As_2O_5, 2.6-7.7 SiO_2, 41-57 ThO_2, 0.0-0.9 UO_2, 0.1-2.9 Y_2O_3, 0.1-6.5 REE_2O_3, 0.0-4.7 Bi_2O_3, 5.8-8.4 CaO, 0.1-0.6 PbO, and 0.4-1.7 F. In contrast, yellow thorites from the quartz zone contain (wt%) 17-20 SiO_2, 36-65 ThO_2, 3-20 UO_2, 0.4-0.8 Al_2O_3, 0.3-0.6 Y_2O_3, 0.2-0.6 REE_2O_3, 0.6-1.0 Bi_2O_3, 0.8-1.3 CaO, 3-17 PbO, and 0.0-0.9 F. Low totals of the microprobe analyses probably indicate the presence of 7-12 wt% H_2O, in agreement with TGA. Infrared spectra confirm the presence of molecular water and are consistent with the presence of mixed types of hydroxyl species. Both varieties of thorite are partially recrystallized. In the brown variety, the degree of crystallinity correlates with increasing substitution of P, V, and Ca for Si and Th. Calculated alpha-event dose (4-12 $\times$ 10^{17} α/mg) are greater than the damage saturation dose ($\sim$1 $\times$ 10^{16} α/mg), but substantial crystallinity is present. The energy barrier to recrystallization of alpha-decay-damaged thorite enriched in P and V is inferred to be lower than for ideal thorite or U-rich microlites from the microcline-spodumene zone.

28681 **Kinetics of ferrate(V) decay in aqueous solution. A pulse-radiolysis study.** Rush, J.D. (Brookhaven National Lab., Upton, NY (USA)); Bielski, B.H.J. *Inorganic Chemistry (USA)*, 28(21): 3947-3951 (18 Oct 1989). DOE Contract AC02-76CH00016.

The kinetic and spectral properties of pentavalent iron derived from pulse-radiolytic reduction of aqueous ferrate(VI) by 2-propanol radicals have been characterized over the pH range 6.3-13. Three forms of iron(V) occur over this pH range, which are represented by the following equilibria: $H_2FeO_4^- \rightleftharpoons H^+ + HFeO_4^{2-}$, pK_2 = 7.5; $HFeO_4^{2} \rightleftharpoons H^+ + FeO_4^{3-}$, pK_3 = 10.1 The protonated forms of ferrate(V) are unstable due to decomposition by a second-order process that results in the formation of hydrogen peroxide and ferric ions rather than disproportionation. The bimolecular rate constants in 1 mM phosphate/borate buffer at 25°C are $k_1(H_2FeO_4^- + H_2FeO_4^-) = (9 \pm 2) \times 10^7$ M^{-1} s^{-1}, k_2 $(H_2FeO_4^- + HFeO_4^{2-}) \approx 3 \times 10^7 M^{-1}$ s^{-1}, $k_3(HFeO_4^{2-} + HFeO_4^{2-}) \approx 1.5 \times 10^7$ M^{-1} s^{-1}, and k_4 $(HFeO_4^{2-} + FeO_4^{3-}) = (1.0 \pm 0.2) \times 10^7$ M^{-1} s^{-1}. At higher pH, FeO_4^{3-} decays by a unimolecular process, $k_1 = 8 \pm 1$ s^{-1}. The very high second-order rates as well as the peroxide product suggest that oxide ligands bound to ferrate(V) may have a much higher degree of free-radical character than does the parent ferrate(VI) ion. 28 refs., 5 figs., 5 tabs.

4007 Radiochemistry and Nuclear Chemistry

Refer also to citation(s) 28024, 28566, 28601, 28892, 29385, 29386, 29387, 29388, 29389, 29390, 29391, 29392, 29393, 29394, 29395, 29396, 29397, 29398, 29399, 29400, 29401, 29402, 29403, 29404, 29405, 29406, 29407, 29408, 29409, 29410, 29411, 29412, 29413, 29414, 29415, 29416, 29417, 29418, 29419, 29420, 29421, 29422, 29423, 29424, 29425, 29426, 29427, 29428, 29429, 29430, 29431, 29432, 29433, 29434, 29435, 29436, 29437, 29438, 29439, 29440, 29441, 29442, 29443, 29444, 29516, 29726, 29851

28682 (CEGB-ESTD/L–0017/R89) **The partitioning of iodides into steam.** Turner, D.J. Central Electricity Research Labs., Leatherhead (UK). Aug 1989. 19p. Order Number DE90624254. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In order to estimate the likely releases of radioactive iodine during steam generator tube rupture (SGTR) faults, it is necessary to know the relevant partition coefficients as a function of temperature and solution composition. It has been suggested previously that, under SGTR fault conditions, partitioning of free or ion-paired I^- into the steam may be more extensive than that for molecular HI. This report uses available information on the partitioning of iodides and other salts to provide a means of estimating the partition coefficient of the iodide ion as a function of boric acid concentration and temperature. (author).

28683 (CIEMAT–623) **Preparation and standardization of a sample of P 32 by liquid scintillation.** Rodriguez, L.; Grau, A.; Los Arcos, J.M.; Suarez, C. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas, Madrid (Spain). 1988. 21p. (In Spanish). Order Number DE90624258. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A procedure to standardize P 32 in liquid scintillation counting by labelling a tsributyl phosphate organic molecule is described. This method shows a high counting efficiency, over 99%, while keeping a good stability of samples in PCS or toluene, which vary less that 1% in two weed periods. The global uncertainty that results for calibrating the radioactive solution through this method has been less that 2.2%. (Author).

28684 (NAC-AR–86-01, pp. 172-176) **The Pretoria cyclotron facility: Production of radioisotopes.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The development and improvement of production procedures and the upgrading and extension of production facilities were continued. Further work was done on the possible simultaneous production of ^{57}Co and ^{109}Cd, and production of ^{67}Ga, ^{77}Br, ^{111}In-oxine and ^{139}Ce. A simple solution has been found to increase the efficiency of the zirconium phosphate $^{81}Rb/^{81m}Kr$ generator to about 80%. Special attention was also given to the quality of our ^{111}In-chloride product for labelling ^{111}In-oxine and ^{111}In-tropolone. Final applications for the registration of ^{111}In-oxine and $^{81}Rb/^{81m}Kr$ generators have been submitted to the Registrar of Medicines. Various improvements and extensions have also been introduced to our production facilities. 7 refs.

4008 Combustion, Pyrolysis, and High-Temperature Chemistry

Refer also to citation(s) 27579, 28283, 28344, 28473, 28597, 28723, 28967

28685 (CONF-900395–1, pp. 130-132) **Mechanisms and controlling characteristics of the catalytic oxidation of methane.** Klier, K. (Lehigh Univ., Bethlehem, PA (USA)); Simmons, G.W.; Herman, R.G. USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The objective of this research is to develop an understanding of the fundamental processes involved in the catalytic conversion of methane to oxygenates and C_2^+ hydrocarbons over noble metal surfaces, i.e. Pd, based on the earlier discovery that Pd may be a potential catalyst for selective methane oxidation under mild reaction temperatures. The novel aspect of the study is the identification of the physical and chemical states of the catalyst surface that activate C-H bonds and enhance the formation of C-O and C-C bonds. In addition, the modification of catalytic properties of the metal catalysts through dissociative adsorption of chlorinated hydrocarbons is of particular interest. Successful achievement of our research goals will provide knowledge of the limiting factors in partial oxidation of methane and will lead to new catalysts for these processes.

28686 (CONF-900395–1, pp. 170-173) **Homogeneous-heterogeneous combustion: Thermal and chemical coupling.** Schmidt, L.D. (Univ. of Minnesota, Minneapolis (USA)). USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div. Mar 1990. From The BES catalysis and surface chemistry research conference; Gaithersburg, MD (USA); 26-28 Mar 1990. In *Seventh BES [Basic Energy Sciences] catalysis and surface chemistry research conference. Summary of DOE-BES research projects.* Order Number DE90008091. Available from NTIS, PC A10/MF A01.

The objectives of this program are to characterize homogeneous-heterogeneous reaction systems in catalytic combustors and chemicals synthesis and to determine how the coupling between homogeneous and heterogeneous reactions controls the rates and selectivities. Four Ph.D. graduate students are working full time on this research and four manuscripts have recently been submitted. All projects involve aspects of homogeneous-heterogeneous reactions on and near metal surfaces in situations from ultrahigh vacuum studies of molecular processes to atmospheric pressure reactor behavior. The program incorporates a variety of experimental approaches to characterize these systems and extensive modeling to simulate processes and to determine the effects of various types of coupling.

28687 (UCRL–102287) **A new experimental approach to study solid combustion reactions using synchrotron radiation.** Holt, J.B.; Wong, J.; Larson, E.; Waide, P.; Rupp, B.; Frahm, R. Lawrence Livermore National Lab., CA (USA). 2 Mar 1990. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900186–1: 1. US-Japanese workshop on combustion synthesis, Ibaraki (Japan), 11-12 Jan 1990). Order Number DE90009405. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have recently utilized the high intensity characteristic of synchrotron radiation and performed a series of proof-of-principle time-resolved x-ray diffraction (TRXRD) experiments at the Brookhaven National Synchrotron Light Source to follow the phase transformations in a number of solid combustion systems in-situ at high temperature. A photo-diode array (Princeton Instrument) which is capable of recording a full scan of 1024 pixels in 4 msec, was used as a position-sensitive detector to record the TR-diffraction patterns from the reacting specimen situated in a specially designed reaction chamber-diffractometer with a vertical θ–2θ geometry. The systems thus far studied include: Ti + C = TiC; Ti + C + xNi = TiC + xNi; Al + Ni = $AlNi_0$. In the latter reaction, we were able to achieve a time resolution of 20 msec and record the formation of pre-reactive phases, melting of the reactants, reaction intermediates and final products in a total scan time of two minutes. These synchrotron experiments open a new route to study the chemical dynamics and phase transformation of reactive systems in-situ, at high temperature and under other external perturbations in the time domain of a few milliseconds which has not been possible before.

28688 (VTT-SYMP–103, pp. 360) **Liquefaction of cotton stalk with acetic acid and sodium hydroxide AT5MPa.** Taner, F. (C. U. Arts and Sciences, Adana (Turkey). Faculty Chem. Dept.); Kimyonsen, U.; Olcay, A. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

Aqueous slurries of cotton stalk dust (20% by weight) were treated with acetic acid and sodium hydroxide (15% by weight of the stalk) at 250, 300 and 350 deg C in a high-pressure autoclave

for one hour starting with 5 MPa initial inert nitrogen gas pressure for liquefaction. The gas formed during the thermochemical treatment was analyzed by Orsat Gas Analyzer. The reaction mixtures were separated into solid-tar and aqueous phases by filtering. The solid-tar phases were extracted with acetone for the determination of oil yield. The calorific values, and the percentages of lignin and CHNO of the solid-tar were determined. It was found that the oil yield, the lignin content and the calorific values of the solid-tar increase as the liquefaction temperature increases. The CO_2 content of the gas decreases with the increase in the thermochemical treatment temperature and the gas becomes more flammable as the operating temperature increases. The ratio of C/O in the solid-tar phases increases as the liquefaction temperature increases. The solid-tar yield of the stalk decreases with the increase of the operating temperature. It can be concluded that the cotton stalk, lignocellulosic in nature, is converted into water-soluble compounds mostly, under these conditions rather than oil.

28689 **Measurement of OH rotational temperatures in a flame using degenerate four-wave mixing.** Dreier, T. (Combustion Research Facility, Sandia National Laboratories, Livermore, California 94551 (US)); Rakestraw, D.J. *Optics Letters (USA)*, 15(1): 72-74 (1 Jan 1990).

Temperatures have been measured in a laminar premixed propane–air diffusion flame using degenerate four-wave mixing (DFWM) of the OH radical. The spectra were recorded simultaneously with laser-induced fluorescence through the (0, 0) band of the OH $A^2\Sigma$–$X^2\Pi$ transition. Individual rotational lines are more clearly resolved in the DFWM spectrum than in the laser-induced fluorescence spectrum, although both are power broadened at laser intensities of 1–2 MW/cm^2 at 307 nm. Rotational temperatures have been determined from the DFWM spectra and are in close agreement with temperatures measured with coherent anti-Stokes Raman spectroscopy of nitrogen.

28690 **Time-resolved two-photon-excited fluorescence detection of atomic hydrogen in flames.** Goldsmith, J.E.M. (Combustion Research Facility, Sandia National Laboratories, Livermore, California 94551 (USA)); Anderson, R.J.M.; Williams, L.R. *Optics Letters (USA)*, 15(1): 78-80 (1 Jan 1990).

We describe time-resolved fluorescence decay measurements of atomic hydrogen in 20-Torr flames using two-photon, 205-nm excitation with 50-psec laser pulses. These studies provide measurements of the variations in collisional quenching rates of hydrogen atoms measured directly in combustion environments.

28691 **Free-radical thermolysis and hydrogenolysis of model hydrocarbons relevant to processing of coal.** Poutsma, M.L. (Oak Ridge National Lab., TN (USA)). *Energy and Fuels (USA)*, 4(2): 113-131 (Mar-Apr 1990). DOE Contract AC05-84OR21400.

Mechanisms are reviewed for thermal decomposition of selected hydrocarbons that serve as models for processing of coal. The hydrocarbon classes emphasized are aromatics, alkylaromatics, α,ω-diarylalkanes, and hydroaromatics, especially tetralin. Perturbations by added sources of hydrogen, especially H_2 and hydroaromatics, are also covered. Free-radical pathways dominate. Emphasis is placed on quantitative understanding of elementary radical processes for bond breaking, bond making, and hydrogen transfer and on the response of the competitions among these to hydrocarbon structure and reaction conditions. Selected implications for coal processing are drawn.

28692 **A thermochemical model for shock-induced reactions (heat detonations) in solids.** Boslough, M.B. (Sandia National Laboratories, Albuquerque, New Mexico 87185 (US)). *Journal of Chemical Physics (USA)*, 92(3): 1839-1848 (1 Feb 1990). DOE Contract AC04-76DP00789.

Recent advances in studies of shock-induced chemistry in reactive solids have led to the recognition of a new class of energetic materials which are unique in their response to shock waves. Experimental work has shown that chemical energy can be released on a time scale shorter than shock-transit times in laboratory samples. However, for many compositions, the reaction products remain in the condensed state upon release from high pressure, and no sudden expansion takes place. Nevertheless, if such a reaction is sufficiently rapid, it can be modeled as a type of detonation, termed "heat detonation" in the present paper. It is shown that unlike an explosive detonation, an unsupported heat detonation will decay to zero unless certain conditions are met. An example of such a reaction is Fe_2O_3 +2Al+shock→Al_2 O_3 +2Fe (the standard thermite reaction). A shock-wave equation of state is determined from a mixture theory for reacted and unreacted porous thermite. The calculated shock temperatures are compared to experimentally measured shock temperatures, demonstrating that a shock-induced reaction takes place. Interpretation of the measured temperature history in the context of the thermochemical model implies that the principal rate-controlling kinetic mechanism is dynamic mixing at the shock front. Despite the similarity in thermochemical modeling of heat detonations to explosive detonations, the two processes are qualitatively very different in reaction mechanism as well as in the form the energy takes upon release, with explosives producing mostly work and heat detonations producing mostly heat.

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Refer also to citation(s) 27675, 28024, 28043, 28048, 28723, 28963, 29909

28693 (AD-A–216945/6/XAB) **Analytical and experimental investigation of miniature heat pipes. Phase 2. Final report, March-December 1988.** Peterson, G.P.; Babin, B.R. Texas A and M Univ., College Station, TX (USA). Dept. of Mechanical Engineering. 24 Jun 1989. 70p. Available from NTIS, PC A04/MF A01.

A combined experimental and analytical investigation was conducted in order to identify and better understand the phenomena which govern the performance limitations and operating characteristics of micro heat pipes - heat pipes so small that the mean curvature of the vapor-liquid interface is comparable in magnitude to the reciprocal of the hydraulic radius of the flow channel. The analytical portion of the investigation began by developing a steady-state model in which the effects of the extremely small characteristic dimensions on the conventional steady-state heat pipe modeling techniques were examined. To further understand the behavior of these types of devices, a transient analytical model was developed, which could be used to predict steady-state and transient behavior during start-up or variations in the evaporator thermal load. In the experimental portion of the investigation, two micro heat pipes, one copper and one silver, in cross-sectional area and in length, were evaluated experimentally to determine the accuracy of both the steady-state and transient model and to provide verification of the micro heat pipe concept. Tests were conducted in a vacuum environment to eliminate conduction and convection losses.

28694 (AEEW-M–2588) **A programme to validate computer codes for container impact analysis.** Neilson, A.J.; Cooper, C.A.; Butler, N. UKAEA Atomic Energy Establishment, Winfrith (UK). Safety and Engineering Science Div. Jun 1989. 10p. Available from H.M. Stationery Office, price Pound 8.00.

The detailed analysis of containers during impacts requires the use of sophisticated computer codes to model the interactions of the various structural components. Three finite element codes, DYNA3D, HONDO-II and ABAQUS, were selected as suitable tools to cover the range of conditions expected in typical impacts. Experiments were performed to examine the codes in progressively more complex models and impact orientations. (U.K.).

28695 (AEEW-M–2589) **Application of DYNA3D to dynamic loading on concrete and steel structures.** Neilson, A.J.; Broadhouse, B.J.; Butler, N.; Attwood, G.J. UKAEA Atomic Energy Establishment, Winfrith (UK). Safety and Engineering Science Div. Jul 1989. 13p. Available from H.M. Stationery Office, price Pound 8.00.

The response of reinforced concrete and steel structures and of transport containers under impact loadings is being studied at Winfrith. The DYNA3D computer code is the primary too used at Winfrith for analyses of these tests and the paper describes

selected applications of the code showing validation against experimental results. (author).

28696 (CONF-900608–10) **An alternative method to solving the kinematics of a redundant robot.** Belmans, P.; Culioli, J.C. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From American Nuclear Society annual meeting; Nashville, TN (USA); 10-15 Jun 1990. Order Number DE90006892. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The state occupied by an m degrees of freedom robot is determined by an articular joint position-vector q of R^m, but usually the specification of a task by its task-vector X takes place in the operational space R^n. Controlling the kinematics of a robot requires to find q as a function of X. In most of the cases, it is impossible to obtain this relationship analytically and globally. The problem is solved by linearization of the geometric model of the robot $X = F(q)$ in the neighborhood of the point q, introducing the $(n \times m)$ Jacobian matrix: $\Delta X = J(q)\Delta q$; $\Delta q \in R^m$; $\Delta X \in R^n$; where ΔX is the variation of task-vector, Δq is the corresponding small variation of the articular position. 8 refs., 1 fig.

28697 (CONF-8910387–1) **The role of automation and robotics in the Lunar-Based Chemical Analysis Laboratory.** Burtis, C.A. Oak Ridge National Lab., TN (USA). [1989]. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 9. College Park colloquium: a lunar-based chemical analysis conference; College Park, MD (USA); 30-31 Oct 1989. Order Number DE90009401. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Lunar-Based Chemical Analysis Laboratory (LBCAL) will be required to provide a wide range of analytical services in an environment of limited physical and human resources. In order to provide these services, it will have to rely on and utilize automated equipment. A wide array of automated analytical equipment is currently available and will have to be evaluated for its suitability for operation in the reduced-gravity conditions of a lunar base. In some cases, specific (e.g., the Medical Demonstration Unit) or core equipment (e.g., centrifugal analyzer) will have to be developed or existing systems modified. In addition, heavy reliance on robotics, both preprogrammed and remotely controlled via a telecommunications linkage (e.g., telerobotics), will be required to compensate for the limited human resources that will be experienced at the lunar base. 14 refs.

28698 (CONF-9005155–1) **Robots for aircraft coatings removal: Parameters and requirements.** Gat, U. Oak Ridge National Lab., TN (USA). [1990]. 3p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. From DOD conference on industry advanced coatings removal; Atlanta, GA (USA); 1-3 May 1990. Order Number DE90009429. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The chemical stripping of coatings of aircraft is being phased out, primarily for environmental reasons. The search is on for methods that are more economical, more efficient, non-damaging and environmentally acceptable. Two of several prime candidates for the new methods are laser stripping and media stripping. Amongst the media stripping methods several are being considered, some of which are plastic media, bicarbonates, and frozen carbon dioxide. To achieve better quality, uniformity, efficiency, and economy and to reduce to a minimum any possible environmental hazards, it is desirable to utilize robots and automatic methods for the aircraft stripping. It is desirable that the robots be flexible and versatile to the extent possible. The flexibility and versatility refers to the ability to recognize and adjust to: variations within an aircraft type; different types of aircraft, including segments of aircraft; accommodation of different stripping methods, primarily laser stripping and plastic media blasting (PMB). However it is realized that flexability or versatility may not be available. Furthermore no practical robots or even partial levels of automation may be readily available for implementation. This paper summarizes desired features and characteristics for robots for coatings removals from aircraft.

28699 (IPPCZ–293/I, pp. 24-56) **Development, investigation and application of plasma reactors with electric arc heating.** Mosseh, A.L. (AN Belorusskoj SSR, Minsk (Byelorussian SSR). Inst. Teplo- i Massoobmena). Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (In Russian). (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Research and development are surveyed of industrial plasma reactors with multistream mixing chambers and arc plasmatrons as heat sources. A unified series of arc plasmatrons with an output of 20 to 200 kW, and plasma heat generators with a total output of up to 0.6 MW based on these plasmatrons were developed in the Minsk Institute. The technical characteristics of the plasmatrons and plasma reactor units are presented as well as the results of investigating the plasma stream in the reactor channel. Studies of thermal and gasdynamic fields and of heat transfer make it possible to optimize the plasma reactors and to form plasma streams with given temperature profiles. Several mathematical models were set up also for plasma processing of dispersive materials. (J.U.).

28700 (IVO-A–10/89) **The development project for a dual-fuel gas-diesel power plant; Part II.** Westergren, R. (Waetsilae Diesel, Helsinki (Finland)); Kauppila, K.; Aho, S.; Saarinen, J.; Miettinen, K.; Kuitunen, T. Imatran Voima Oy (IVO), Helsinki (Finland). 1989. 74p. (In Finnish). Order Number DE90770763. Available from NTIS (US Sales Only), PC A04/MF A01.

In the second part of the development project for a dual-fuel gas-diesel power plant, a system for the supply and injection of gas was developed and the engine itself was turned to a commercial product; a module-based diesel heating power plant was developed and a preliminary plan was drawn up to construct a pilot plant in Jaervenpaeae. The tests and trial runs proved that a diesel engine equipped with a high-pressure gas injection enables the exploitation of the diesel process, high efficiency and power. As a result of the project a concept was completed for a module-based small-scale power plant with an output of 7/7 MW and 14/14 MW. Simultaneously a preliminary plan was completed to build a unit of 7/7 MW in Jaervenpaeae. The development project could reduce the investment costs for the power plant by some 15% from the pre-study values despite the extra costs caused by nitrogen reduction. Thanks to nitrogen reduction NO_x emissions decreased by 80-90%. The market for a gas-diesel power plant and gas engine is expanding rapidly as the cogeneration market and natural gas supply are increasing. Not only Finland, but also Sweden and Denmark, will be interesting countries in the near future. Electricity generated in a gas-diesel power plant is competitive with electricity from a coal-fired power plant if the price for gas is moderate. Features characteristic of each city will affect the profitability.

28701 (JAERI-M–89-218) **Task planning systems with natural language interface.** Kambayashi, Shaw (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Uenaka, Junji. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 64p. (In Japanese). Order Number DE90777757. Available from NTIS (US Sales Only), PC A04/MF A01.

In this report, a natural language analyzer and two different task planning systems are described. In 1988, we have introduced a Japanese language analyzer named CS-PARSER for the input interface of the task planning system in the Human Acts Simulation Program (HASP). For the purpose of a high speed analysis, we have modified a dictionary system of the CS-PARSER by using C language description. It is found that the new dictionary system is very useful for a high speed analysis and an efficient maintenance of the dictionary. For the study of the task planning problem, we have modified a story generating system named Micro TALE-SPIN to generate a story written in Japanese sentences. We have also constructed a planning system with natural language interface by using the CS-PARSER. Task planning processes and related knowledge bases of these systems are explained. A concept design for a new task planning system will be also discussed from evaluations of above mentioned systems. (author).

28702 (JAERI-M–89-219) **Dynamics analysis of robot manipulator: Computer simulation for two-linkage mechanism.** Sasaki, Shinobu (Japan Atomic Energy Research Inst., Tokai,

Ibaraki (Japan). Tokai Research Establishment); Shinohara, Yoshikuni; Usui, Hozumi. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 40p. (In Japanese). Order Number DE90777758. Available from NTIS (US Sales Only), PC A03/MF A01.

This paper is concerned with a basic problem of dynamics of spatial mechanisms. The problem of dynamics for obtaining the driving forces and torques that will realize the prescribed motion, the so called direct problem, leads to dealing with expressions which becomes extremely involved with increasing number of links. From the practical standpoint, it is desirable that this complexity of dynamical equations be simplified by means of introduction of reduced models with well-grounded approximation. To this end, attention was directed towards analysis of two-link mechanisms having some of the fundamental functions in ordinary manipulator to accumulate experience of better simulation of dynamical movements. Through examination of analytical results, the various mechanical effects were clearly identified in torque behaviors of individual joints. (author).

28703 (N–90-15363) **Feasibility analysis of reciprocating magnetic heat pumps. Final report.** Larson, A.V.; Hartley, J.G.; Shelton, S.V.; Smith, M.M. Georgia Inst. of Tech., Atlanta, GA (USA). Dec 1989. 59p. (NASA-CR–186205;NAS–1.26:186205). Available from NTIS, PC A04/MF A01.

A reciprocating gadolinium core in a regeneration fluid column in the warm bore of a superconducting solenoidal magnet is considered for magnetic refrigeration in 3.517 MW (1000 ton) applications. A procedure is presented to minimize the amount of superconducting cable needed in the magnet design. Estimated system capital costs for an ideal magnetic refrigerator of this type become comparable to conventional chillers as the frequency of reciprocation approaches 10 Hertz. A 1-D finite difference analysis of a regenerator cycling at 0.027 Hertz is presented which exhibits some of the features seen in the experiments of G. V. Brown.

28704 (N–90-16686, pp. 226-269) **On the selection of materials for cryogenic seals and the testing of their performance.** Russell, J.M. University of Central Florida, Orlando, FL (USA). Oct 1989. (NASA-CR–166837;NAS–1.26:166837;CONF-8906315–: NASA/ASEE summer faculty fellowship program conference, Merritt Island, FL (USA), 5 Jun 1989). In *NASA/ASEE Summer Faculty Fellowship Program.* Available from NTIS, PC A18/MF A03.

Three questions are addressed: what mission must a cryogenic seal perform; what are the contrasts between desirable and available seal materials; and how realistic must test conditions be. The question of how to quantify the response of a material subject to large strains and which is susceptible to memory effects leads to a discussion of theoretical issues. Accordingly, the report summarizes some ideas from the rational mechanics of materials. The report ends with a list of recommendations and a conclusion.

28705 (SAND–89-2666C) **Slotted-wall research with disk and parachute models in a low-speed wind tunnel.** Macha, J.M. (Sandia National Labs., Albuquerque, NM (USA)); Buffington, R.J.; Henfling, J.L.; Every, D. Van; Harris, J.L. Sandia National Labs., Albuquerque, NM (USA). [1990]. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900672–1: 16. AIAA aerodynamic ground testing conference, Seattle, WA (USA), 18-20 Jun 1990). Order Number DE90002989. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An experimental investigation of slotted-wall blockage interference has been conducted using disk and parachute models in a low speed wind tunnel. Test section open area ratio, model geometric blockage ratio, and model location along the length of the test section were systematically varied. Resulting drag coefficients were compared to each other and to interference-free measurements obtained in a much larger wind tunnel where the geometric blockage ratio was less than 0.0025. 9 refs., 10 figs.

28706 (SAND–89-3134C) **A refrigerated Dewar for the Josephson array voltage calibration system.** Duncan, R.V. Sandia National Labs., Albuquerque, NM (USA). [1989]. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900689–2: Conference on precision electromagnetic measurements, Ottawa (Canada), 11-14 Jun 1990). Order Number DE90005237. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A refrigerated Dewar has been used successfully with the Josephson array voltage calibration system. It has been used to re-liquefy helium with no degradation of the calibration system's performance. The independence of the array voltage from temperature has been confirmed to three parts in 10^8 per Kelvin using this Dewar. 6 refs., 3 figs.

28707 (SAND–90-0099C) **Security alarm communication and display systems development.** Waddoups, I.G. Sandia National Labs., Albuquerque, NM (USA). [1990]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900608–7: American Nuclear Society annual meeting, Nashville, TN (USA), 10-15 Jun 1990). Order Number DE90006044. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Sandia National Laboratories (SNL) has, as lead DOE physical security laboratory, developed a variety of alarm communication and display systems for DOE and DOD facilities. This paper will briefly describe some of the systems developed and conclude with a discussion of technology relevant to those currently designing, developing, implementing, or procuring such a system. 4 refs., 1 fig.

28708 (SAND–90-0223C) **Clean room designs: State of the art today and directions in the 1990s.** Brown, N.E. Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005156–1: Millipore 1990 microelectronics technical symposium, Santa Clara, CA (USA), 21 May 1990). Order Number DE90009512. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Traditional laminar flow and mixed flow clean rooms have evolved substantially since their inventions in the 1960s. There have been major advanced in the attainable cleanliness levels in the cleanroom; however, the most important consideration is the cleanliness of the environment immediately surrounding the wafer. The clean bay/utility chase concept substantially reduced contamination associated with equipment maintenance and repair, and delivering gases and chemicals to the tool. This concept also permitted modification and installation of new process tools with minimum impact on other processes. However, both the ballroom, and the bay and chase designs have high operational and construction costs. The 1990s begin with increased emphasis on integrated and processing and cluster tools where the strategy is on creating and maintaining a clean environment around the wafer. To achieve these goals, an array of new and improved concepts to insure clean wafer processing will be required. With escalating equipment costs and process complexity, it will be critical for manufacturing personnel to support and repair highly automated processing systems and to maintain the high mean time between failure. Techniques to permit realistic process development on the production line will be essential. New concepts for chemical distribution, purification, reprocessing, and recycling will also be necessary. The interrelationship between these and many other issues will be discussed in an effort to predict what effect they will have on modern fabs in the 1990s. 19 refs.

28709 (STEV-FBT–89-49) **Dust separation capacity of a stone bed filter with heat recovery.** Ljungstroem, E. (Chalmers Univ. of Tech., Goeteborg (SE). Dept. of Inorganic Chemistry). Statens Energiverk, Stockholm (Sweden); Chalmers Univ. of Tech. and Univ. of Goeteborg, Goeteborg (Sweden). Dept. of Inorganic Chemistry. 1989. 28p. (In Swedish). Project STEV-276-372. (CTH-OOK–89-02). Order Number DE90770793. Available from NTIS (US Sales Only), PC A03/MF A01.

The dust retention characteristics of a stone-bed filter was investigated. The filter is of a novel type and combines dust separation with heat recovery from a flue gas. The investigated filter is serving two wood-fired units with a total power of 1.1 MW. Together with a pre-cyclone, the filter reduces the dust loading of the clean gas to between 20 and 40 m/m^3 (STP). The filter retains mainly large particles and no separation was observed for submicron particles. The process waste is cleaning water and sludge. The water contains dissolved inorganic salts from the wood ashes and the sludge partly consists of unburned material. In the present case about 53 % of

the accessible energy in the flue gas was recovered. The recovery is negatively influenced by the low water content of the flue gas.

28710 (STEV-FJV–90-2) **Development and functional testing of CFC-free PUR insulation for conduit joints.** Jarfelt, U. (Chalmers Univ. of Tech., Goeteborg (SE). Dept. of Building Technology). Statens Energiverk, Stockholm (Sweden). Nov 1989. 29p. (In Swedish). Project STEV-656-101. Order Number DE90770855. Available from NTIS (US Sales Only), PC A03/MF A01.

The aim of the project was both to adapt the foaming equipment for field work to CO_2-blown polyurethane insulation and development and functional testing CO_2-blown PUR insulation. In total 3 test series of 12 joints each were made. The joint sleeves consisted of transparent material and were fixed to a conduit of DN 125/250 dimension. The temperature conditions chosen for assessment of the quality of the joint foam in question were in the main based on the recommendations in GEN/TC 107, WG 4 'Joints', Document nr 1, Draft nr 11, August 1989. In this document it is recommended that the temperature on the joint boundary surfaces should be between 10 and 45 deg C. The temperatures on the joint casing surface have in the test series been varied between 12 and 27 deg C and on the fluid tube between 8 and 60 deg C. (7 figs., 4 tabs.).

28711 (UCRL–102777) **Joining the visiting team.** Sperling, R.B. Lawrence Livermore National Lab., CA (USA). 4 Jan 1990. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9004155–1: Society of American Value Engineers international conference, Baltimore, MD (USA), Apr 1990). Order Number DE90009033. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

As an extention of "The Selection and use of VA/VE Professionals" this paper addresses the questions of: What will guarantee success for the VE studies? Will the Job Plan always produce a study that saves 10% and yields a return on investment of 30:1? What help does the VE team need for it to do its job more effectively? What work does the VE site coordinator need to do to raise the implementation rate on VE studies performed by visiting teams? 3 refs.

28712 (UCRL-JC–103312) **Function library programming to support B89 evaluation of Sheffield Apollo RS50 DCC [Direct Computer Control] CMM [Coordinate Measuring Machine].** Frank, R.N. Lawrence Livermore National Lab., CA (USA). 28 Feb 1990. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9003141–1: NWC-CMM user group conference, Golden, CO (USA), 20-21 Mar 1990). Order Number DE90009947. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Inspection Shop at Lawrence Livermore Lab recently purchased a Sheffield Apollo RS50 Direct Computer Control Coordinate Measuring Machine. The performance of the machine was specified to conform to B89 standard which relies heavily upon using the measuring machine in its intended manner to verify its accuracy (rather than parametric tests). Although it would be possible to use the interactive measurement system to perform these tasks, a more thorough and efficient job can be done by creating Function Library programs for certain tasks which integrate Hewlett-Packard Basic 5.0 language and calls to proprietary analysis and machine control routines. This combination provides efficient use of the measuring machine with a minimum of keyboard input plus an analysis of the data with respect to the B89 Standard rather than a CMM analysis which would require subsequent interpretation. This paper discusses some characteristics of the Sheffield machine control and analysis software and my use of H-P Basic language to create automated measurement programs to support the B89 performance evaluation of the CMM. 1 ref.

28713 **An optical alarm for vacuum traps.** Duncan, M.G. (Martin Marietta Energy Systems, Inc., Y-12 Development Division, Instrumentation and Characterization Dept., Oakridge, TN (US)); Henry, J.J. pp. 584 of Proceedings of the IEEE instrumentation and measurement technology conference. IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8904110–: IEEE instrumentation and measurement technology conference, Washington, DC (USA), 25-27 Apr 1989).

This paper reports on an optical alarm for large industrial vacuum systems developed to prevent overflow of vacuum filters and traps. The alarm prevents two problems: nuclear reactions when the dirt contains both radioactive materials and water and overload of the vacuum system. The level of dirt in the trap is detected by the attenuation of light across the trap. Water in the trap is detected by light refraction at large angles of incidence to the water surface. To minimize sensitivity to dirty trap walls, a second detector measures light attenuation across the empty section of the trap and is used to normalize the first detector output. Logic circuits minimize sensitivity to large chunks of dirt moving in the trap.

4204 Heat Transfer and Fluid Flow

Refer also to citation(s) 27654, 27842, 27955, 28056, 28283, 28347, 28455, 28456, 28744, 28986, 29027, 29360

28714 (CONF-900617–3) **Fluidelastic instabilities in tube bundles exposed to nonuniform crossflow.** Chen, S.S. (Argonne National Lab., IL (USA)); Chandra, S. Argonne National Lab., IL (USA). [1990]. 42p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-31109-ENG-38. From Pressure vessels and piping conference: be in tune for the 90's; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE90003818. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A mathematical model is presented for fluidelastic instabilities in tube bundles exposed to nonuniform crossflow to develop an equivalent flow velocity. The model incorporates all motion-dependent fluid forces based on the unsteady flow theory. Published fluid-force coefficients are compiled and examined; all fluid-force coefficients are approximately independent of the reduced flow velocity when it is large but are strongly dependent on reduced flow velocity when it is lower. The unsteady flow model is used to show that the mode-weighted averaging method is valid for large reduced flow velocity, but that it is incorrect at lower reduced flow velocity. In the lower reduced flow velocity range, an iterative procedure is needed to establish the critical flow velocity. The results from the unsteady flow model are compared with those of other mathematical models. A general procedure is recommended to predict the equivalent flow velocity under different situations. 24 refs., 10 figs., 2 tabs.

28715 (DOE/ER/14043–1) **Numerical and physical modelling of bubbly flow phenomena: Progress report, July 1, 1989–March 31, 1990.** Prosperetti, A. (Johns Hopkins Univ., Baltimore, MD (USA)); Sangani, A.S. Johns Hopkins Univ., Baltimore, MD (USA); Syracuse Univ. Research Inst., NY (USA). Dept. of Chemical Engineering. Mar 1990. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER14043. Order Number DE90009837. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The ultimate purpose of this study is to put the widely used engineering averaged-equations models of multi-phase flows on a firmer footing by comparing their results with those of direct numerical multi-particle simulations and rigorously-derived averaged equations. Since the averaged-equations models are comparatively well developed, in the first year of this project we have focused on the multi-particle simulation and ensemble averaging techniques. This report describes the progress to date on the several problems that are being studied. The first problem addresses the derivation of ensemble-averaged equations for the propagation of pressure waves in bubbly liquids. The result is in the form of an expansion for small gas volume fraction. Previously known results are recovered at first order and in certain limits at higher order. However, a new insight into the structure of the expansion and the role of bubble-bubble interaction and surface deformations is obtained from this work. 10 refs., 2 figs.

28716 (KEK–89-2, pp. 20-23) **A study on molecular flow by Monte Carlo method.** Tominaga, Goro (Toho Univ., Funabashi, Chiba (Japan). Faculty of Science). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques*

for accelerators and storage rings. Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

The Monte Carlo method has been widely used to determine the Clausing's factor in vacuum studies, since it has been demonstrated that molecular motions in a state where a molecular flow condition is valid can be simulated accurately by the Monte Carlo method. In the present study, the motions of molecules in a conduit with a circular cross section where a molecular flow condition is valid are analyzed by Monte Carlo simulation in an effort to identify some features of the molecular motions under a molecular flow condition. A particle entering a conduit will either return through the entrance or get out of the conduit though the exit in the end. The mean path length is equal to twice the length of the conduit (L). In the L/D (D: diameter of conduit) range where the end effect can be ignored, the mean path length of the return particles is almost constant at around 1.5, while that of the through particles increase linearly with L/D. Another study is carried out to analyze the mean total number of collisions of the molecules with the wall. Simulation is also made for the effective mean free path, which is defined as the mean free path length between a molecule-wall collision and the next collision with the wall. (N.K.).

28717 (LA-UR–90-856) **Turbulence in slurry pipe flow.** Gore, R.A. (Los Alamos National Lab., NM (USA)); Crowe, C.T. Los Alamos National Lab., NM (USA). [1990]. 6p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900651–3: International symposium on nonsteady fluid dynamics, Toronto (Canada), 4-7 Jun 1990). Order Number DE90008940. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The present state of knowledge of liquid-solid flows (slurries) is far behind than that for single phase flows. Very few geometries have been examined with a slurry and only with a limited variation of system parameters i.e. fluid viscosity, particle diameter, etc. This paper presents the first part of a study which examines the effects of the addition of a solid to the flow through a confined coaxial jet. Presented here will be the initial conditions for the jet which correspond to fully developed pipe flow. 6 refs., 9 figs.

28718 (LA-UR–90-857) **Experimental observations on transition to turbulence in confined coaxial jets and other boundary layer flows.** Gore, R.A. (Los Alamos National Lab., NM (USA)); Crowe, C.T.; Bejan, A. Los Alamos National Lab., NM (USA). [1990]. 7p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900651–2: International symposium on nonsteady fluid dynamics, Toronto (Canada), 4-7 Jun 1990). Order Number DE90008939. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Experiments performed demonstrate the transition to turbulent flow of water jets discharging coaxially into a stream confined in a round duct. The critical Reynolds number is shown to be a strong function of velocity ratio. From the flow visualization it is shown that a proportionality between the laminar length of the jet (L) and the wavelength (λ) can be seen in the region of transition to turbulence. The proportionality coincides with similar observations concerning the transition to turbulence in various other flows. A brief argument based on scale analysis is presented for the confined coaxial jet and round plume. The apparent universality of the $L/\lambda \sim O(10)$ scaling law supports the conclusion that the laminar sections of all naturally progressing boundary layer-type flows are geometrically similar. 21 refs., 8 figs.

28719 (LNCC–019/89) **Finite element approximation of a new variational principle for compressible and incompressible linear isotropic elasticity.** Franca, L.P. (Helsinki Univ. of Technology, Espoo (Finland). Inst. of Mathematics); Stenberg, R. Laboratorio Nacional de Computacao Cientifica, Rio de Janeiro, RJ (Brazil). Jun 1989. 16p. Order Number DE90624851. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

To be published in "Applied Mechanics Reviews".

Stability conditions are described to analyze a variational formulation emanating from a variational principle for linear isotropic elasticity. The variational principle is based on four dependent variables (namely, the strain tensor, augmented stress, pressure and displacement) and is shown to be valid for any compressibility including the incompressible limit. An improved convergence error analysis is established for a Galerkin-least-squares method based upon these four variables. The analysis presented establishes convergence for a wide choice of combinations of finite element interpolations. (author).

28720 (LNCC–028/89) **Application of a mixed Galerkin/least-squares method to axisymetric shell problems subjected to arbitrary loading.** Loula, A.F.D.; Toledo, E.M.; Franca, L.P.; Garcia, E.L.M. Laboratorio Nacional de Computacao Cientifica, Rio de Janeiro, RJ (Brazil). Aug 1989. 12p. Order Number DE90624852. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A variationaly consistent finite element formulation for constrained problems free from shear or membrane locking is applied to axisymetric shells subjected to arbitrary loading. The governing equations are writen according to Love's classical theory for a problem of bending of axisymetric thin and moderately thick shells accounting for shear deformation. The mixed variational formulation, in terms of stresses and displacements here presented consists of classical Galerkin method plus mesh-dependent least-square type terms employed with equal-order finite element polynomials. The additional terms enhance stability and accuracy of the original Galerkin method, as already proven theoretically and confirmed trough numerical experiments. Numerical results of some examples are presented to demonstrate the good stability and accuracy of the formulation. (author).

28721 (LNCC–029/89) **Modelling and simulation of an energy transport phenomenon in a solid-fluid mixture.** Costa, M.L.M.; Sampaio, R.; Gama, R.M.S. da. Laboratorio Nacional de Computacao Cientifica, Rio de Janeiro, RJ (Brazil). Aug 1989. 17p. (In Portuguese). Order Number DE90624853. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In the present work a model for a local description of the energy transfer phenomenon in a binary (solid-fluid) saturated mixture is proposed. The heat transfer in a saturated flow (through a porous medium) between two parallel plates is simulated by using the Finite Volumes Method. (author).

28722 (OEFZS–4524) **The dynamics of heat transfer at a turbulent pipe flow.** Schmidl, H. Oesterreichisches Forschungszentrum Seibersdorf GmbH (Austria). Dec 1989. 61p. (In German). (EA–339/89). Order Number DE90624854. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The temperature distribution of a turbulent pipe flow will be described at a system of differential equations. With changing several parameters these equations are solved. (Author).

28723 (ORNL/FTR–3573) **[Design and installation of a 150-KW electron-beam furnance]: Foreign trip report, March 6–15, 1990.** Sikka, V.K. Oak Ridge National Lab., TN (USA). 6 Apr 1990. 25p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90009867. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report summarizes the findings of the review meetings on a 150- kW electron-beam furnace on order with Leybold-Heraeus Technologies. The specific objectives of these meetings were (1) to review the project status, (2) to finalize the design of the system, (3) to review the mechanical and electrical drawings, (4) to discuss the installation requirements, (5) to develop plans for the furnace acceptance test, and (6) to discuss the details of shipping and the installation at the Oak Ridge National Laboratory. All of these objectives were met during the 2-1/2-day meetings. As a result of these meetings, LH agreed to include changes that will enhance the furnace utility and installation. These included: (1) the addition of an auxiliary control box for the horizontal feeder, (2) the modification of the water flow channel to minimize the dead space in the copper hearth, (3) a change in the roughing line to better fit the furnace in the allotted space, (4) the design of the platform surrounding the furnace, and (5) a modification of the platform design to better fit the power supplied in the space underneath. A better understanding of the programmable logic controller was obtained. The shipping and installation requirements were clarified. 6 figs.

28724 (PB–90-859729/XAB) **Heat exchanger tube vibrations. January 1970-January 1990 (A Bibliography from the**

COMPENDEX data base). Report for January 1970-January 1990. National Technical Information Service, Springfield, VA (USA). Feb 1990. 95p. Available from NTISPC N01/MF N01.

Supersedes PB–85-861201.

This bibliography contains citations concerning design, fabrication, and vibration studies of heat exchanger tubes. Basic excitation mechanisms of tube vibrations, effects of heat exchanger configurations, preoperational testing of tubes, and vibration detection techniques are discussed. Model studies and computer simulation techniques are presented. (This updated bibliography contains 226 citations, 72 of which are new entries to the previous edition.)

28725 (POEF-T–3522) **Recirculating cooling water solute depletion models.** Price, W.T. Portsmouth Gaseous Diffusion Plant, OH (USA). 16 Mar 1990. 12p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-76OR00001. Order Number DE90009990. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Chromates have been used for years to inhibit copper corrosion in the plant Recirculating Cooling Water (RCW) system. However, chromates have become an environmental problem in recent years both in the chromate removal plant (X-616) operation and from cooling tower drift. In response to this concern, PORTS is replacing chromates with Betz Dianodic II, a combination of phosphates, BZT, and a dispersant. This changeover started with the X-326 system in 1989. In order to control chemical concentrations in X-326 and in systems linked to it, we needed to be able to predict solute concentrations in advance of the changeover. Failure to predict and control these concentrations can result in wasted chemicals, equipment fouling, or increased corrosion. Consequently, Systems Analysis developed two solute concentration models. The first simulation represents the X-326 RCW system by itself; and models the depletion of a solute once the feed has stopped. The second simulation represents the X-326, X-330, and the X-333 systems linked together by blowdown. This second simulation represents the concentration of a solute in all three systems simultaneously. 4 figs.

28726 (UCRL-JC–103243-Rev.1) **Plane Stokes flow driven by capillarity on a free surface: Overview and status: Revision 1.** Hopper, R.W. Lawrence Livermore National Lab., CA (USA). 26 Mar 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900684–1-Rev.1: 5. international colloquium on free boundary problems: theory and applications, Montreal (Canada), 13-22 Jun 1990). Order Number DE90009290. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This article summarizes some recent work on the creeping viscous incompressible plane flow in a region, bounded by a simple smooth closed curve and driven solely by surface tension. Such problems are self-contained in that the applied tractions are intrinsic in the geometry. The objective is to determine exactly the time evolution of the shape of the region. The problems are fundamentally nonlinear due to the large changes in shape, and it is emphasized that no mathematical approximations are made. Mathematical details, discussions of general concepts, and references to related work are included which deals primarily with finite regions. Further articles are in preparation, including extensions to unbounded and doubly-connected regions. 6 refs., 2 figs.

28727 (WSRC-RP–89-1438) **Parallel channel flow excursions.** Johnston, B.S. Westinghouse Savannah River Co., Aiken, SC (USA). [1990]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-900187–1: VPI conference, Blacksburg, VA (USA), 22 Jan 1990). Order Number DE90009129. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Among the many known types of vapor-liquid flow instability is the excursion which may occur in heated parallel channels. Under certain conditions, the pressure drop requirement in a heated channel may increase with decreases in flow rate. This leads to an excursive reduction in flow. For channels heated by electricity or nuclear fission, this can result in overheating and damage to the channel. In the design of any parallel channel device, flow excursion limits should be established. After a review of parallel channel behavior and analysis, a conservative criterion will be proposed for avoiding excursions. In support of this criterion, recent experimental work on boiling in downward flow will be described. 5 figs.

28728 Fluid flow calculations using a multigrid method and an improved discretization scheme. Vanka, S.P. (Argonne National Lab., IL (USA). Materials and Components Technology Div.); Mongia, H.C.; Karki, K.C. *Numerical Heat Transfer (USA)*, 16(2): 143-160 (1989).

In this study the use of a multigrid method with an improved discretization scheme has been investigated for the solution of the fluid flow equations. The flux-spline scheme has been employed for convection-diffusion in the transport equations. The solution algorithm is based on a coupled solution of the continuity and momentum equations in conjunction with a multigrid method. Two test problems have been considered to assess the performance of the solution procedure. The flux-spline scheme leads to accurate solutions without requiring excessively fine grids. The solution algorithm is shown to be robust and rapidly convergent.

4205 Materials Testing

Refer also to citation(s) 27904, 27941, 28075, 28248, 28343, 28760, 28761, 29803

28729 (JAERI-M–89-187) **SATCAP-B: a program for thermal-hydraulic design of 'Saturated Temperature Capsule'.** Harayama, Yasuo (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Someya, Hiroyuki; Niimi, Motoji. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 64p. (In Japanese). Order Number DE90777738. Available from NTIS (US Sales Only), PC A04/MF A01.

As an advanced irradiation technique, the JMTR (Japan Materials Testing Reactor) project is developing a 'Saturated Temperature Capsule' which water is injected in and boiled. When the water is kept at a constant pressure, the water temperature does not become higher than the saturated temperature. This type capsule is based on the conception of keeping the coolant to the saturated temperature and using the temperature control. In designing the capsule in which the inner coolant is injected, thermal performances have to be understood as exactly as possible. Then, a program (named SATCAP) was compiled to graps the thermal performance within the capsule. On the other hand, a 'Saturated Temperature Capsule' was made and irradiated in the JMTR core. It was indicated from supplied water temperatures recorded by thermo-couples attached in the capsule that heat transfer coefficients prefered models due to natural convection to models incorporated in the initial version of the program. Then, the program was revised by adding mainly heat transfer model based on natural convection. The present report describes the calculation procedure and guides of input and output for the revised program (SATCAP version-B). (author).

28730 (ORNL/Sub–87-SA946/01) **An examination of selected NDE methods for ceramic composite tubes.** Dunyak, T.J. (Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (USA). Dept. of Engineering Science and Mechanics); Reifsnider, K.L.; Stinchcomb, W.W. Oak Ridge National Lab., TN (USA); Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (USA). Center for Composite Materials and Structures. 15 Dec 1989. 83p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. (CCMS–89-18). Order Number DE90009901. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The main thrusts of the VPI&SU program are to develop elevated temperature test methods for complex components, to characterize the damage development process, and to develop life prediction capabilities for such components. This report examines a variety of NDE methods to meet these needs of the VPI&SU program. Although limited to methods currently available at VPI&SU, the investigation covers a wide range of methods from typical optical microscopy to highly developmental techniques such as acousto-ultrasonics and scanning acoustic microscopy. The first section of this report briefly describes the design, fabrication, and material of the VPI&SU specimen. In addition, three quasi-static tension tests will be described. The second section forms the bulk of this report. First, some of the background and concerns when applying any NDE method will be discussed. Next short synopses of the examined methods will be presented. The next section summarizes the NDE results in conjunction with a series of quasi-static

tension test results. We will attempt to correlate the initial defects, observed damage development, and failure surface analysis in order to identify the critical defects in the component. The final section presents a summary of the entire report and lists which methods are currently planned for use in the VPI&SU program.

28731 (SAND–90-0534C) **Data and conclusions from tests on small screws.** Cawfield, J.L.; Ernest, T.L.; Reese, R.T. Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9006122–3: International conference on micromechanics of failure of quasi-brittle materials, Albuquerque, NM (USA), 7-8 Jun 1990). Order Number DE90007500. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The integrity of many mechanical assemblies and electrical components depends on small threaded fasteners. The design standards for small (less than $\frac{1}{4}$ inch in diameter) screws made of stainless steel are not as well developed as those for larger sizes of high strength steels. The typical design approach is based on the application of static design principals. Steady state accelerations are applied to the component or assembly and sufficient screws are installed in mounting hardware for attachment to the next assembly. These design principals have been used successfully for years in a wide variety of applications. As the parts requiring small screws have continued to decrease in size, some design requirements include greater thread depths and adherence to strict interpretation of the governing thread standards. These design requirements have their origins in the lack of adequate definitions and standards for designs using small threaded fasteners. These design practices have led to significant problems in manufacturing parts with small threaded fasteners by requiring thread depths to four and more diameters of engagement while maintaining thread heights (radial engagement) of 75 percent throughout the thread interfaces. A test program was developed to address questions regarding design and manufacturing issues involving small threaded fasteners which included tensile strength, length of engagement needed to achieve the full strengths of the screws, and verification of the static design principals in dynamic conditions. This paper summarizes the initial results obtained to date from this test program and describes the work-in-progress on the dynamic tests with their related static tests. 2 refs., 4 figs., 4 tabs.

28732 (VTT-TIED–1053) **Non-destructive measurement of wood characteristics: Part 5. Gamma measurements.** Lappalainen, T. (Valtion teknillinen tutkimuskeskus, Espoo (Finland). Puulaboratorio). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Sep 1989. 43p. (In Finnish). Order Number DE90770750. Available from NTIS (US Sales Only), PC A03/MF A01.

This project explains the use gamma-ray attenuation for determination of local moisture content or density variations in wood. Gamma-rays are ideal for local measurements, because the beam can be accurately focused. Exellent correlation was found between gamma-ray attenuation and density of dry wood. Also moisture content of wood can be accurately determined if dry density can be measured separately. When the moisture content of wood is higher than 30% by dry weight, moisture content can be determined directly from gamma-ray attenuation without knowing of the density. The results of this projects are used to design an equipment for determination of local moisture content and density variations in wood samples.

28733 (VTT-TIED–1059) **Non-destructive measurement of wood: Part 3. Sound measurements.** Lankinen, A. (Valtion teknillinen tutkimuskeskus, Espoo (Finland). Puulaboratorio). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Sep 1989. 30p. (In Finnish). Order Number DE90770751. Available from NTIS (US Sales Only), PC A03/MF A01.

Mechanical vibrations from infrasounds below 20 Hz to ultrasound above 20 KHz are becoming more popular in the non-destructive testing of wood. Moduli of elasticity correlate with sound velocity and density, and the slope of the grain with sound velocity. Analyses of wave attenuation, sound velocity and density enable a reliable model to be created for strength of wood composites. Ultrasound waves bounce off defects in the wood such as knots and cracks, forming a holographic picture of the internal structure.

4210 Combustion Systems

Refer also to citation(s) 27502, 27507, 27806, 27938, 28274, 29031

28734 (PJM–CE02952, pp. 122-132, Paper 23) **Bioenergy for steam generation.** Topley, A.W.R. (Babcock and Wilcox Canada, Cambridge, ON (Canada)). Murray (P.J.) and Associates Ltd., Ottawa, ON (Canada). 1982. (CONF-8211204–: ; CE–02952). In *Proceedings of the conference on biomass: An alternative source of energy*. Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum.

This report reviews the capabilties and limitations of the most common types of furnaces used today with biomass fuels. Dutch oven furnaces can handle high moisture (65%) fuels without requiring auxiliary fuel assistance, and require little fuel preparation. Ashes have to be removed from the furnace by raking and auxiliary fuel may have to be burned during this process. The flat pinhole grate furnace can burn fuels of moisture content 55 to 60%, have a steam production capacity of 30,000 to 300,000 pph. Ashes have to be manually raked from this furnace but removal is easier than from the dutch oven furnace. Steeply sloping pinhole grate furnaces have a steam capacity up to 450,000 pph and automatic ash removal. It can handle fuels with moisture contents up to 60%. The the travelling grate furnace is the most versatile in the type of fuels it can burn, has a capacity up to 450,000 pph of steam, will burn fuels up to 55% moisture without support fuels, and has automatic ash removal. The mass burning furnace is complex and costly, has a capacity range of 30,000 pph to 250,000 pph, does not require any fuel preparation, and can handle municipal garbage directly from the truck. Mass burning units must be operated at a high excess of air to prevent corrosion of metal surfaces and premature failure. The suspension burner, has a high capital cost, a capacity for 400,000 to 1,200,000 pph of steam, and requires extensive fuel preparation. It can burn biomass fuels in conjunction with fossil fuels. The report closes with a review of the preparation typically required for different types of biomass fuels. 12 figs.

4220 Mining and Underground Engineering

Refer also to citation(s) 28146

28735 (KIB-RUB-TWM–85-6) **Sprayed concrete for tunneling and mining.** Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau. Sep 1985. 230p. (In German). (CONF-8502162–: 3. colloquium on sprayed concrete for tunneling and mining, Bochum (Germany, F.R.), 13 Feb 1985). Available from Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau.

The 3rd Colloquium on Constructional Process Engineering was held in February 1985 at the Ruhr-Universitaet, Bochum, under the title 'Sprayed concrete in tunneling and mining'. Lectures were presented in the fields of machinery, applications, materials technology and measuring techniques, and industrial safety and experimental techniques. The colloquium was accompanied by a demonstration of concrete spraying machines, spraying manipulators, arched supports, grid supports, and concrete materials and fluxes. Separate records are available for 12 papers. (MOS).

28736 (KIB-RUB-TWM–85-6, pp. 11-25) **The significance of gunlting methods and lining materials to the construction of tunnels.** Maidl, B. (Bochum Univ. (Germany, F.R.). Lehrstuhl fuer Bauverfahrenstechnik und Baubetrieb). Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau. Sep 1985. (In German). (CONF-8502162–: 3. colloquium on sprayed concrete for tunneling and mining, Bochum (Germany, F.R.), 13 Feb 1985). In *Sprayed concrete for tunneling and mining*. Available from Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau.

Today's tunneling technology has its world-wide basis on a wide range of application of shotcrete and thus gains enormous economic significance. The relations between different materials and the load of the rock on the temporary support and the structural analysis are discussed. At present the state of knowledge is unable to keep up with the requirements on shotcrete in praxis. This will be analysed in terms of material behaviour, technology of application, equipment and environmental questions. The necessity

for further research is derived. Finally the advantages of steel fibre shotcrete are explained. (orig.).

28737 (KIB-RUB-TWM–85-6, pp. 27-37) **New developments in the field of shotcreting systems.** Schwing, F. (Schwing (F.W.) GmbH, Herne (Germany, F.R.)). Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau. Sep 1985. (In German). (CONF-8502162–: 3. colloquium on sprayed concrete for tunneling and mining, Bochum (Germany, F.R.), 13 Feb 1985). In *Sprayed concrete for tunneling and mining.* Available from Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau.

Mobile wet shotcreting systems in operation on jobsites of the Federal German Railway achieve high outputs with minimum rebound and without dust production. This ever-familiar, rediscovered shotcreting method which is more economical in point of installed power and wear makes the strict observance of the specified concrete recipes possible and ensures a uniformly high concrete quality at a predetermined water/cement ratio. (orig.).

28738 (KIB-RUB-TWM–85-6, pp. 39-54) **Current status of guniting aids.** Handke, D. (Bochum Univ. (Germany, F.R.). Lehrstuhl fuer Bauverfahrenstechnik und Baubetrieb). Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau. Sep 1985. (In German). (CONF-8502162–: 3. colloquium on sprayed concrete for tunneling and mining, Bochum (Germany, F.R.), 13 Feb 1985). In *Sprayed concrete for tunneling and mining.* Available from Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau.

After an introductory presentation of the first applications of remote-controlled boom machines in practice it will be reported by aid of different systems about those types of equipment which for the time being is offered on the national and international market. The systems are to distinguish with view to the kinematic of their booms and their shotcrete nozzles. Advantages and disadvantages of the use with remote-controlled boom machines in tunneling will be shown. Last but not least it will be reported about problems of kinematics concerning the requirements of nozzle guide. (orig.).

28739 (KIB-RUB-TWM–85-6, pp. 73-86) **Development of single-shell construction methods with examples. Report of Bochum Stadtbahnbau.** Sager, H.J. (Stadt Bochum (Germany, F.R.). Abt. fuer Baudurchfuehrung des Stadtbahnbauamtes). Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau. Sep 1985. (In German). (CONF-8502162–: 3. colloquium on sprayed concrete for tunneling and mining, Bochum (Germany, F.R.), 13 Feb 1985). In *Sprayed concrete for tunneling and mining.* Available from Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau.

In the centre of Bochum-City has been built for the first time a tunnel in a one-shell construction, 1500 m long. The temporary shotcrete support was performed according to the NATM which in the end became part of the final support. Then the cast-in place concrete shell was constructed and connected to the shotcrete shell by friction respectively by steel bars. In this way both shells together now bear the final load. (orig.).

28740 (KIB-RUB-TWM–85-6, pp. 147-162) **Measuring techniques for determination of the load on the outer shell in the critical phase.** Berg, J. (Bochum Univ. (Germany, F.R.). Lehrstuhl fuer Bauverfahrenstechnik und Baubetrieb). Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau. Sep 1985. (In German). (CONF-8502162–: 3. colloquium on sprayed concrete for tunneling and mining, Bochum (Germany, F.R.), 13 Feb 1985). In *Sprayed concrete for tunneling and mining.* Available from Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau.

The paper describes a simple method to achieve quantitative statements within the sphere of the face of the tunnel. Results are the 'typical effects caused by a partial excavation' under certain conditions of geomechanics and tunnel construction. The effects represent a suitable help to estimate the geology, the stiffness of the shotcrete and the steel arch as well as the particular phases of excavation and supporting work. (orig.).

28741 (KIB-RUB-TWM–85-6, pp. 191-200) **Accident preparation and industrial safety aspects in sprayed-concrete working.** Goenner, D. (Tiefbau-Berufsgenossenschaft, Muenchen (Germany, F.R.)). Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau. Sep 1985. (In German). (CONF-8502162–: 3. colloquium on sprayed concrete for tunneling and mining, Bochum (Germany, F.R.), 13 Feb 1985). In *Sprayed concrete for tunneling and mining.* Available from Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau.

Sprayed concrete is used for sanitation measures in concrete structures, excavations, slopes, and underground caverns. It is either dry-sprayed or wet-sprayed. The article discusses the health hazards and accident risks in dry spraying, which is the more risky process of the two and also the more common. Health hazards and accident risks during excavations, the risk factor contributed by the technique used, the pertinent regulations, and the studies carried out in the course of the BMFT research projects on humanisation of labour (HdA) in the field of concrete spraying are gone into. (MOS).

28742 (KIB-RUB-TWM–85-6, pp. 201-219) **The concrete guniting test rig at Bochum Ruhr University.** Hahlhege, R. (Bochum Univ. (Germany, F.R.). Lehrstuhl fuer Bauverfahrenstechnik und Baubetrieb). Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau. Sep 1985. (In German). (CONF-8502162–: 3. colloquium on sprayed concrete for tunneling and mining, Bochum (Germany, F.R.), 13 Feb 1985). In *Sprayed concrete for tunneling and mining.* Available from Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau.

In the following paper it will be reported about the factors influencing the quality of shotcrete in the course of the process as they show how necessary it is to research more and intensively. Moreover, there will be presented aspects with view to requirements for shotcrete material and methods as well as requirements for its application in practice. Possibilities are given to obtain the qualitative and quantitative data by the shotcrete testing plant. Last but not least it will be reported about first results of an actual research programme in connection with the above. (orig.).

28743 (VTT-TIED–1069) **Soil and rock grouting: Preliminary study.** Poellae, J. (Valtion teknillinen tutkimuskeskus, Espoo (Finland). Geotekniikan laboratorio). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Oct 1989. 71p. (In Finnish). Order Number DE90770754. Available from NTIS (US Sales Only), PC A04/MF A01.

This study is based on literature survey and deals with soil and rock grouting. The properties of cement and clay based grouting materials are presented as well as their future development trends. An overview of chemical grouting materials and their properties is also given. New grouting techniques including the use of dynamic pressure, jet grouting and compaction grouting are briefly discussed. These techniques are not well-known in Finland and their suitability in Finnish ground conditions should be tested. There are no really efficient methods to control the quality of grouting. The geophysical methods seem to be most promising in this area. On the basis of this study needs for further research are presented.

4250 Power Cycles

28744 A parametric analysis microcomputer model for evaluating the thermodynamic performance of a reciprocating Brayton cycle engine. Tsongas, G.A. (Mechanical Engineering Dept, Portland State Univ, Portland, OR (US)); White, T.J. *Journal of Engineering for Gas Turbines and Power (USA),* 111(1): 587-594 (Oct 1989).

A Brayton open-cycle engine is under development. It operates similarly to a gas turbine engine, but uses reciprocating piston compressor and expander components. The design appears to have a number of advantages, including multifuel capability, the potential for lower cost, and the ability to be scaled to small sizes without significant loss in efficiency. An interactive microcomputer model has been developed that analyzes the thermodynamic performance of the engine. The model incorporates all the important irreversibilities found in piston devices, including heat transfer, mechanical friction, pressure losses, and mass loss and recirculation. There are 38 input parameters to the model. Key independent operating

parameters are maximum temperature, compressor rpm, and pressure ratio. The development of the model and its assumptions are outlined in this paper. The emphasis is on model applications.

4260 Components, Electron Devices and Circuits

Refer also to citation(s) 27852, 28091, 28491, 28498, 28512, 28513, 28534, 28543, 28550, 28551, 28793, 28922, 28923, 28925, 28927, 28929, 28932, 28933, 28935, 28936, 28937, 28964, 29345, 29597, 29710, 29712, 29747, 29755, 29756, 29764, 29765, 29826, 29844

28745 (AD-A–216980/3/XAB) **III-V semiconductor quantum-well lasers and related opto-electronic devices on silicon. Technical report.** Holonyak, N.; Hsieh, K.C.; Stillman, G.E. Illinois Univ., Urbana, IL (USA). Dec 1989. 31p. (TR–2). Available from NTIS, PC A03/MF A01.

The research goal is to further develop quantum well heterostructure (QWH) lasers and to realize reliable Al(x)Ga(1-x)As-GaAs QWH lasers on Si. In spite of the significant lattice and thermal expansion mismatch between GaAs and Si, the idea of splicing III-V semiconductor technology, i.e., optoelectronics and photonics, onto Si has obvious appeal. Adding to this is the fact, as shown earlier in this work, that cw 300 K Al(x)Ga(1-x)As-GaAs QWH lasers can be grown on Si, and that the Si substrate serves as a better heat sink than GaAs. This makes possible the right-side-up heat sinking needed for electronic-photonic integrated circuits. This report contains research results on quantum well heterostructures on Si, impurity-induced layer disordering, phonon-assisted laser operations and other laser studies.

28746 (AD-A–216990/2/XAB) **Flash-lamp-pumped Ti:Al_2O_3 laser using fluorescent conversion.** Lacovara, P.; Esterowits, L.; Allen, R. Naval Research Lab., Washington, DC (USA). Jun 1985. 3p. Available from NTIS, PC A01/MF A01.

Pub. in Optics Letters, Vol. 10, 273-275(Jun 1985).

We have achieved efficient room-temperature flash-lamp-pumped laser operation in titanium-doped sapphire. The laser has a threshold of 20 J, a slope efficiency of 0.5%, an output energy in excess of 300 mJ, and a tuning range (with our present optics) of 720-920 nm. Ways of reducing the lasing threshold and increasing slope efficiency are discussed.

28747 (AD-A–217036/3/XAB) **Excited-state absorption of pump radiation as a loss mechanism in solid-state lasers.** Kliewer, M.L.; Powell, R.C. Oklahoma State Univ., Stillwater, OK (USA). Dept. of Physics. Aug 1989. 7p. Available from NTIS, PC A02/MF A01.

Pub. in IEEE Jnl. of Quantum Electronics, Vol. 25, No. 8, 1850-1854(Aug 1989).

The characteristics of optical pumping dynamics occuring in laser-pumped rare earth-doped, solid-state laser materials were investigated by using a tunable alexandrite laser to pump Y3Al5O12:Nd(3+) in an optical cavity. It was found that the slope efficiency of the Nd laser operation depends strongly on the wavelength of the pump laser. For pump wavelength resulting in low slope efficiencies, intense fluorescence emission is observed form the sample in the blue-green spectral region. This is attributed to the excited state absorption of pump photons which occurs during radiationless relaxation from the pump band to the metastable state. This type of process will be an important loss mechanism for monochromatic pumping of laser systems at specific pump wavelengths.

28748 (CONF-9006122–4) **Determination of internal strains in high-temperature superconductor composites by intense pulsed neutron source.** Singh, J.P.; Kupperman, D.S.; Majumdar, S.; Hitterman, R.L. Argonne National Lab., IL (USA). Feb 1990. 10p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From International conference on micromechanics of failure of quasi-brittle materials; Albuquerque, NM (USA); 7-8 Jun 1990. Order Number DE90007799. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Results are presented for the effect of silver (Ag) addition on microstructure, mechanical properties, and internal strains in $YBa_2Cu_3O_{7-\delta}$–Ag superconducting composites. A 2.2 fold increase in strength was obtained as a result of ~20 vol% Ag addition to $YBa_2Cu_3O_{7-\delta}$ without any adverse effects on superconducting properties. The increase in strength is believed to be due to an increase in density as well as due to the development of internal compressive strains in the $YBa_2Cu_3O_{7-\delta}$ matrix as a result of Ag addition. The internal strains developed due to thermal expansion mismatch between $YBa_2Cu_3O_{7-\delta}$ and Ag were measured by neutron diffraction using intense Pulsed Neutron Source at Argonne National Laboratory. Creep may play an important role in relaxing the residual strains in composite constituents. 5 refs., 5 figs., 1 tab.

28749 (DOE/ET/29017–T1) **Microprocessor-based control for an ac-dc power conversion system with dc interrupter protection: Final report 82-9G2-INTER-R1, June 1, 1979–December 31, 1982.** Kovalsky, L.J.; Putkovich, R.P. Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center. 20 Dec 1982. 84p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC01-76ET29017. Order Number DE83010602. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The use of microprocessors in power converted controls is of interest, since they could potentially reduce system costs, increase system adaptability, and enhance system reliability where analog circuitry is conventionally used. This report discusses the techniques that were applied in designing a complete microprocessor-controlled ac/dc power conversion system, including thyristor-gating control and closed-loop regulation of system voltages. The project also served as a vehicle for further evaluation of a ringing-bypass valve dc interrupter that had been previously designed in work related to the ac/dc conversion system used here. The microprocessor control techniques described here are applicable to most energy conversion systems where a dc power source exchanges energy with an ac network via line-commutated converters. 4 refs., 33 figs.

28750 (EGG-M–89350) **Beam propagation in direct nuclear pumped laser amplifiers.** Neuman, W.A.; Fincke, J.R.; Lassahn, G.D.; Montierth, L.M. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-891261–9: International conference on lasers '89, New Orleans, LA (USA), 3-8 Dec 1989). Order Number DE90009613. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Thermal distortions in transverse flow, direct nuclear pumped laser amplifiers and the resulting effect on beam propagation is investigated. Nuclear pumping occurs from surfaces, either from plates parallel to the flow direction, from screens or porous material perpendicular to the flow direction, or from the combination of the two. The analysis presented is topically divided into the analysis of the energy deposition of the energetic charged particles in the amplifying media and the analysis of the beam propagation in the amplifier and to the far field. The spatially varying energy deposition produces large index of refraction variations in the nuclear pumped amplifier. These variations are modeled by a Zernike polynomial expansion and their effect on the propagation of a uniform intensity plane wave is discussed. For purposes of illustration, an amplifier with a 1 m gain length and a 1 atm (101 kPa) argon gas flowing at 100 m/s is presented. With approximately 150 W/cm^3 average charged particle pumping in the amplifier the beam qualities range from 7 to 27 times diffraction limited when the primary (tilt and focus) aberrations in the amplifier are corrected. 3 refs., 8 figs., 4 tabs.

28751 (KCP–613-4303) **New flexible circuit material evaluation.** Fossey, D.J. Allied-Signal Aerospace Co., Kansas City, MO (USA). Kansas City Div. Mar 1990. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00613. (CONF-9006121–3: 4. international SAMPE electronic materials and processes conference, Albuquerque, NM (USA), 12-14 Jun 1990). Order Number DE90008313. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A project has been undertaken to evaluate new sources of flexible circuit materials for use by Allied-Signal, Inc., Kansas City Division. The vast majority of current flexible circuits are fabricated

from polyimide film and acrylic adhesive circuit materials. One new polyimide film was evaluated as an alternate dielectric film. Thirteen (13) suppliers of flexible circuit materials have been identified. The results of the mechanical and electrical properties evaluation study of some of the new sources of flexible circuit materials are discussed. 5 tabs.

28752 (MLM-MU-90-64-0003) **Ignition testing of low-energy laser diode ignited components.** Ewick, D.W.; Beckman, T.M. EG and G Mound Applied Technologies, Miamisburg, OH (USA). 16 Apr 1990. 23p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. Order Number DE90009968. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Laser diode ignition tests were performed on various explosive and pyrotechnic materials, including $TiH_x/KClO_4$, BCTK, barium styphnate, and several CP-based blends. Under standard test conditions, the threshold energy levels for laser diode ignition of $Ti/KClO_4$, $TiH_{0.65}/KClO_4$, and $TiH_{1.65}/KClO_4$ were all between 2.8 and 3.3 mJ. The blending of carbon black with CP significantly lowered the energy required for laser diode ignition. The most sensitive blend tested contained 3.2 wt % carbon black and had a threshold level of 0.47 mJ for a 10 ms laser diode pulse. Various techniques for reducing the energy required for laser diode ignition of energetic materials were also evaluated. The use of graded index fiber rather than step index fiber lowered the threshold of both $Ti/KClO_4$ and carbon black-doped CP by approximately 30%. A 0.05-mm thick Mylar insulator between the optical fiber and powder reduced the threshold energy by roughly 40%. Although powder density was found to have a significant effect on the energy required to ignite $Ti/KClO_4$, the threshold of carbon black-doped CP was unaffected by density. 6 refs., 8 figs.

28753 (PB-90-121906/XAB) **C-w CO_2 laser with auxiliary-glow DC discharge.** Noda, E.; Suzuki, S.; Morimiya, O. Toshibe Corp., Tokyo (Japan). Principal Office. c 1989. 5p. Available from NTIS, PC A05/MF A01.

Text in Japanese; Included in Toshiba Review, Vol. 44, No. 6, 513-516(1989).

A new method of auxiliary glow-DC-discharge between an anode and auxiliary electrodes has been developed for a transverse-flow CW-CO2 laser excited by glow-DC-discharge. The maximum input power was increased to a remarkable extent with the addition of the auxiliary discharge, and an output power exceeding 7.5kW/m was obtained at a discharge length of 40 cm. The saturation intensity of the laser was found to be inversely proportional to the beam diameter. An equation giving the output power for a Z-path resonator was deduced, and the calculated results agreed with the experimental results obtained.

28754 (PB-90-123159/XAB) **Sealed-off carbon dioxide laser.** Ikeda, H.; Horishima, T.; Owaki, T. Japan Radio Co. Ltd., Tokyo (Japan). c 1988. 10p. Available from NTIS, PC A06/MF A01.

Text in Japanese; Included in Japan Radio Company Review No. 26, 51-59(1988).

In general, CO_2 lasers offer eminent oscillation efficiency and high output powers in comparison with other types of laser. On the other hand, CO_2 lasers have a principal drawback of transient output power fall due to CO_2 gas dissolution during discharge. The gas-flowing CO_2 laser is surely more practical in this point, but it requires large equipment such as exhaust equipment and a gas cylinder. The sealed-off CO_2 laser that the author's have taken up is suitable for medical use and precision machining because of smaller equipment and easier maintenance than the gas-flowing CO_2 laser, while its output power and lifetime have to be improved. To solve these problems with CO_2 lasers, the author's have introduced two kinds of catalizers in the sealed-off CO_2 laser tube and obtained 60 W/m output power per unit discharge length, which is comparable to that of the gas-flowing CO_2 laser, and its lifetime has been improved to be more than 3000 h, long enough for practical use.

28755 (PB-90-860370/XAB) **Pulse techniques for laser applications. January 1970-April 1987 (A Bibliography from the Searchable Physics Information Notices data base). Report for January 1970-April 1987.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 118p. Available from NTISPC N01/MF N01.

See also PB-90-860388.

This bibliography contains citations concerning theoretical, experimental, and applied pulse techniques associated with various types of lasers. Considerable attention is given to pulse techniques in laser research and laser technology. (This updated bibliography contains 310 citations, none of which are new entries to the previous edition.)

28756 (PB-90-860388/XAB) **Pulse techniques for laser applications. May 1987-January 1990 (A Bibliography from the Searchable Physics Information Notices data base). Report for May 1987-January 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 47p. Available from NTISPC N01/MF N01.

Supersedes PB-87-859021. See also PB-90-860370.

This bibliography contains citations concerning theoretical, experimental, and applied pulse techniques associated with various types of lasers. Considerable attention is given to pulse techniques in laser research and laser technology. (This updated bibliography contains 83 citations, all of which are new entries to the previous edition.)

28757 (PB-90-860800/XAB) **Carbon dioxide lasers. September 1980-February 1988 (A Bibliography from the NTIS data base). Report for September 1980-February 1988.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 159p. Available from NTISPC N01/MF N01.

See also PB-90-860818.

This bibliography contains citations concerning theory, design, operation, output, and diagnostics of CO_2 lasers. Included are studies relating to excitation, frequency conversion, modulation, laser pumping, reaction kinetics, gas dynamics, and plasmas. The development and efficiency of optical components, such as mirrors, resonators, tuning devices, infrared optical materials, amplifiers, and gratings are also discussed. (This updated bibliography contains 350 citations, none of which are new entries to the previous edition.)

28758 (PB-90-860818/XAB) **Carbon dioxide lasers. March 1988-January 1990 (A Bibliography from the NTIS data base). Report for March 1988-January 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 59p. Available from NTISPC N01/MF N01.

Supersedes PB-88-859137. See also PB-90-860800.

This bibliography contains citations concerning theory, design, operation, output, and diagnostics of CO_2 lasers. Included are studies relating to excitation, frequency conversion, modulation, laser pumping, reaction kinetics, gas dynamics, and plasmas. The development and efficiency of optical components, such as mirrors, resonators, tuning devices, infrared optical materials, amplifiers, and gratings are also discussed. (This updated bibliography contains 91 citations, all of which are new entries to the previous edition.)

28759 (SAND-89-2425C) **Heat-transfer regimes in nuclear-reactor-pumped gas lasers.** Torczynski, J.R. Sandia National Labs., Albuquerque, NM (USA). [1990]. 27p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900619-1: 5. AIPA/ASME thermophysics and heat transfer conference, Seattle, WA (USA), 18-20 Jun 1990). Order Number DE90002904. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The flow induced in nuclear-reactor-pumped gas lasers by the competing effects of spatially nonuniform fission-fragment heating (pumping) and heat transfer to the walls is examined. The equations of motion are acoustically filtered (low Mach number approximation), and the resulting equations are seen to have three timescales: the duration of the heating, the time required by the heating to produce a pressure rise comparable to the initial pressure, and the time for the thermal boundary layer to grow into the center of the laser cell. Three distinct regimes emerge from consideration of the relative magnitudes of these timescales. In the negligible-conduction regime, thermal-conduction effects are small, and the motion is determined by the spatial nonuniformity of the

heating. In the dominant-conduction regime, thermal-conduction effects govern the motion. In the mixed regime, the effects of thermal conduction and heating nonuniformity are comparable, but since they are oppositely directed, a complex gas motion results. Analytical solutions to the equations of motion are presented for the negligible-conduction and dominant-conduction regimes, and examples are given for all three regimes. Plots of the second spatial derivative of the density field (a quantity often used in optical analyses) are given for the negligible-conduction and the dominant-conduction regimes as functions of the appropriate similarity parameters. 26 refs., 14 figs.

28760 (SAND–89-2617C) **Dynamic response of a complex encapsulated electronic assembly subjected to a severe shock environment.** Burchett, S.N. Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9006121–2: 4. international SAMPE electronic materials and processes conference, Albuquerque, NM (USA), 12-14 Jun 1990). Order Number DE90007689. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Several complex encapsulated electronic assemblies electrically failed after they were exposed to very severe mechanical shock tests. Postmortem examination showed that a microcomputer ceramic substrate in each assembly was cracked. The stress history in the ceramic substrate was determined using finite element computer analyses to assist in the evaluation of the failures. The purposes of the analyses were (1) to determine the cause of the failures, (2) to evaluate contributing factors, and (3) to evaluate possible design changes. The results of the analyses compared favorably with experimental results and clearly indicated that ceramic substrate failure during the shock test was possible. The analyses indicated that the natural frequency of the encapsulated assembly was essentially "tuned" to the resonant plate primary frequency causing amplified responses and high stresses. Additional calculations provided guidance for design improvements that reduced stress levels generated by the severe shock environment. 10 figs., 1 tab.

28761 (SAND–89-2730C) **Severe shock and vibration environments for electronic components.** Martinez, D.R. Sandia National Labs., Albuquerque, NM (USA). [1990]. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9006121–1: 4. international SAMPE electronic materials and processes conference, Albuquerque, NM (USA), 12-14 Jun 1990). Order Number DE90007686. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Electronic components used in system applications must be qualified to mechanical shock and vibration environments. Often these environments are severe, requiring the development and use of special test techniques and procedures. Environmental specifications are based upon analytical model predictions and measured test data. Test specifications are determined after careful consideration of simulation techniques, input levels, dynamic behavior of the test fixturing, as well as an assessment of the degree of conservatism imposed by the specification and testing procedures. The process of determining component shock and vibration specifications is discussed, beginning with the initial description of system and subsystem level environments, and concluding with component level test specifications. Included is a discussion of the difference between environmental specifications and test specifications, and the instrumentation/measurement problems associated with obtaining valid field measurements for severe shock data. The role of finite element analysis in predicting the dynamic structural response of components is also explained. Shock data analysis techniques are described including both time-domain and frequency-domain characterizations of the data. The resonant plate shock testing technique for simulating severe shock environments is presented, including difficulties that arise in practical applications. 18 refs., 10 figs.

28762 (SAND–90-0081C) **Using a new generation of multimeters to measure the quantized resistance.** Cage, M.E. (National Inst. of Standards and Technology, Gaithersburg, MD (USA)); Steiner, R.L.; Yu, D.Y.; Jeckelmann, B.M.; Duncan, R.V. Sandia National Labs., Albuquerque, NM (USA); National Inst. of Standards and Technology, Gaithersburg, MD (USA). [1990]. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900689–1: Conference on precision electromagnetic measurements, Ottawa (Canada), 11-14 Jun 1990). Order Number DE90005316. Available from NTIS, PC A02/MF A01 - OSTI.

A new generation of digital multimeters was used to compare the ratios of the resistances of wire-wound reference resistors and quantized Hall resistances. The accuracies are better than 0.1 ppM for ratios as large as 4:1 if the multimeters are calibrated with a Josephson array. 9 refs.

28763 (UCRL–101792) **An assessment of the hardness of miniature vacuum tubes to high-voltage transients.** Orvis, W.J. Lawrence Livermore National Lab., CA (USA). Mar 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-891097–5: High powered microwave and broadband radio frequency propagation/phenomenology/methodology workshop, Livermore, CA (USA), 23-26 Oct 1989). Order Number DE90009541. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Miniature vacuum tubes are vacuum switching and control devices fabricated on a silicon wafer, using the same technology as is used to make integrated circuits. They operate in much the same manner as conventional vacuum tubes, but with two important differences: they are micron sized devices, and they employ field emission instead of thermionic emission as the electron source. As these devices have a vacuum as their active region, they will be extremely hard to nuclear radiation and relatively insensitive to temperature effects, they are also expected to be extremely fast devices. We have estimated here that their hardness to high-voltage transients will be at least as good as existing semiconductor devices and possibly better. 5 figs.

28764 (UCRL-CR–103293) **Injection-seeded Nd:YAG laser linewidth measurement using saturation spectroscopy in iodine.** Faris, G.W. (SRI International, Menlo Park, CA (USA). Molecular Physics Lab.); Dyer, M.J. Lawrence Livermore National Lab., CA (USA); SRI International, Menlo Park, CA (USA). Molecular Physics Lab. 7 Dec 1989. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90009537. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We describe the application of two-laser saturation spectroscopy in iodine for the measurement of the time-averaged linewidth of an injection-seeded Nd:YAG laser. Linewidths as narrow as 23 MHz have been measured. 2 refs., 1 fig.

28765 (UCRL-CR–103371) **Reactions of $N_2(A^3\Sigma_u^+)$ and candidates for short wavelengths lasers: Final report, June 1, 1986–September 30, 1989.** Setser, D.W. (Kansas State Univ., Manhattan, KS (USA). Dept. of Chemistry). Lawrence Livermore National Lab., CA (USA); Kansas State Univ., Manhattan, KS (USA). Dept. of Chemistry. [1990]. 159p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90009514. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The final report for this contract consists of the Chapters of the PhD Dissertation of Glenn Lo that are concerned with the Spectroscopy and Kinetics of $SO(A^3\pi)$. Glenn Lo was supported by the Livermore contract during the 1988–1989 period. Glenn currently is employed at Northwest Louisiana University, thus this DOE support did directly contribute to the scientific manpower pool in the US. The technique for generating SO(X) and the quenching rate constants for SO(A) were reported in Chem. Phys. Lett. 149, 384 (1988). The new spectroscopic data, the spin-orbit state relaxation rates and some additional electronic quenching data in Glenn's thesis will be condensed to a manuscript for J. Chem. Phys. during the Summer of 1990. This manuscript will provide a summary for the relaxation and quenching rate constants of SO(A). From the scientific point of view, the results are quite interesting since reliable data for $^3\Pi_{0,1,2}$ electronic states are scarce. Unfortunately, from the energy storage point of view, the quenching rates of SO(A) by He and Ar are too large for SO(A) to be a good energy storage candidate. 32 refs., 46 figs., 6 tabs.

28766 (UCRL-JC–103338) **Short pulse driven recombination x-ray lasers.** Keane, C.J.; Bardsley, J.N.; da Silva, L.; Landen, N.; Matthews, D. Lawrence Livermore National Lab., CA (USA). 16 Mar 1990. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900140–21: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 15-19 Jan 1990). Order Number DE90009945. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The advent of compact high peak power short pulse lasers has made tabletop recombination x-ray lasers pumped by these systems a real responsibility. In this paper we discuss some of the relevant issues for these lasers and highlight a number of issues that require consideration. Results of simulations designed to estimate potential gains in the quasi-steady-state region are also described. 22 refs., 2 figs.

28767 (VTT-PUB–54) **Analysis of an R-SQUID noise thermometer.** Seppae, H. (Valtion teknillinen tutkimuskeskus, Espoo (Finland). Saehkoe- ja automaatiotekniikan lab.). Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). May 1989. 90p. Order Number DE90770764. Available from NTIS (US Sales Only), PC A05/MF A01.

In this thesis the metrological performances of the R-SQUID intended to be used as a cryogenic thermometer is verified. The R-SQUID consists of the Josephson junction which converts voltage noise from the shunt resistor into frequency fluctuations. Measuring the value of the shunt resistor and the variance of the frequency fluctuations, the temperature of the bath can be determined. Unformutunately, the absolute temperature determination is disturbed by several effects: a rolloff introduced by a post-detection filter, additional noise caused by the rf amplifiers, a mixed noise effect caused by the nonlinearity of the Josephson junction togethet with rf noise in the tank circuit, and the limited number of the frequency countrs. In aaidition, the determination of the shunt resistor may cause a systematic error. In the work the influence of the post-detection filter and the additive noise on the frequency variance is analyzed and the analytic models for the dc impedance and the noise performances of the R-SQUID are derived. All our theoretical models are nowadays experimentally verified; some of the experiments are reported in this work. The analytic models are used to estimate the total inaccuracy of the noise thermometer and to find the optimal choice of the device parameters. The work reveals that the utimate accuracy of the temperature determination is proportional to the total measurement time and the pump frequency and inversely proportional to the noise temperature of the preamplifier. This work shows that the R-SQUID is complex gauge to maintain a cryogenic temperature scale. However, the careful choice of the device parameter and the point of operation, the use of the low-noise cooled preamplifier, and the operation at high pump frequencies, enable very accurate determination of the temperature of the bath in which the R-SQUID is immersed.

28768 Dither free stabilization of CH_3OH pumping sources. Bennett, C.A. (North Carolina Univ., Asheville, NC (USA)); Patterson, J.D.; Hutchinson, D.P. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

A dither free stabilization scheme was reported recently in which the optical transmission through an absorption cell filled with CH_2F_2 provided an error signal necessary to stabilize the 214 μm line of CH_2F_2. Measurements have indicated that this technique is difficult to apply to the 119 μm line of CH_3OOH over the tuning range of the pump. Efforts to find a non-lasant gas with the required absorption features and to develop a similar technique base on the photoacoustic technique are described.

28769 Turnable chromium lasers. Chase, L.L. (Univ. of California, Lawrence Livermore National Lab., Livermore, CA (US)); Payne, S.A. pp. 307 of Laser applications in meteorology and earth and atmospheric remote sensing. Sokoloski, M.M. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8901157–: Laser applications in meteorology and earth and atmospheric remote sensing, Los Angeles, CA (USA), 16-18 Jan 1989).

Since the discovery of the alexandrite laser, many other tunable vibronic sideband lasers based on Cr^{3+} have been developed. These lasers span the wavelength range from 700 nm to at least 1235 nm. Experimental and theoretical research has provided an understanding of the important factors that influence the performance of these Cr^{3+} lasers and other solid state vibronic lasers. The intrinsic performance levels of some of the most promising Cr^{3+} lasers are evaluated from extrapolated slope efficiency measurements.

28770 A high efficiency diffraction grating design for a rhomb configuration. Wantuck, P.J. (Los Alamos National Lab., NM (USA)); Appert, Q.D.; Gratrix, E.J.; Hopkins, A.A. pp. 277 of Current developments in optical engineering III. Fischer, R.E.; Smith, W.J. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). (CONF-8808213–: Current developments in optical engineering III, San Diego, CA (USA), 15-18 Aug 1988).

A diffraction grating rhomb is an excellent candidate for both suppressing sideband instabilities in a tree electron laser (FEL) and outcoupling the optical beam. A rhomb incorporating sinusoidal profile gratings exhibits many of the required performance characteristics for such an application. The authors present in detail a description of such a rhomb and include a rhomb alignment sensitivity analysis.

28771 A computer controlled 300 kV pulse generator. Kupferman, S.L. (Sandia National Labs Primary Standards Lab, Division 7242, Albuquerque, NM (US)); Booker, S.R.; Meissner, H.J. pp. 584 of Proceedings of the IEEE instrumentation and measurement technology conference. IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8904110–: IEEE instrumentation and measurement technology conference, Washington, DC (USA), 25-27 Apr 1989).

This paper reports high voltage pulse generator used primarily for calibrating precision high voltage dividers redesigned and rebuilt for state of the are operation. It now has the capability to run a divider calibration, compare the results with historical data for the divider, and then print a calibration certificate, all under computer control. Thirteen component instruments are controlled via IEEE 488 buses. A voice synthesizer is used to inform the operator of the progress of the calibration. Measurement precision is in the 0.1% range. A heat exchanger is used to control the temperature of the oil bath to allow calibration of dividers between 13°C (55°F) and 21°C (70°F). Positive or negative pulse polarity may be selected and pulse magnitude is settable from less than 10 kv to greater than 300 kv.

28772 Resonator design with an intracavity time-varying index gradient. Neal, D.R. (Sandia Labs., Albuquerque, NM (USA)); Sweatt, W.C.; Torczynski, J.R. pp. 277 of Current developments in optical engineering III. Fischer, R.E.; Smith, W.J. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). (CONF-8808213–: Current developments in optical engineering III, San Diego, CA (USA), 15-18 Aug 1988).

Side-pumped lasers such as flashlamp or reactor-pumped lasers often have a nonuniform energy deposition in the gain medium, which can establish a significant transverse index gradients. This gradient significantly complicates energy extraction. A normalized resonator analysis method is developed that predicts resonator stability transitions and mode sizes for parabolic index fields. Parameter studies for some practical classes of resonators are presented, along with some design guidelines. Experimental comparison for a long-pulse gas laser shows good agreement with stability transitions times. Two resonator-design approaches are presented for increasing the extraction efficiency in the presence of intracavity index gradients.

28773 Comparison of experimental and numerical results on microwave coupling into cylindrical enclosures. Turner, C.D. (Sandia National Lab. Albuquerque, NM (USA)); Bacon, L.D. pp. 474 of Proceedings of the IEEE 1988 international symposium on electromagnetic compatibility. IEEE Service Center, Piscataway,

NJ (USA) (1988). (CONF-880847–: International symposium on electromagnetic compatibility, Seattle, WA (USA), 2-4 Aug 1988).

Comparisons are made between microwave measurements and numerical analyses on several RF shielding enclosures. CW measurements in the frequency range from 45 MHz to 2 GHz are compared with a numerical model based on the cartesian finite-difference time-domain technique. Agreement of the numerical results with the measurements is good considering the model limitations. The value of both the numerical result and the measurement is enhanced by their agreement.

28774 Progress toward a superconducting opening switch. Humphreys, D.R. (Sandia National Labs., Albuquerque, NM (USA)); Francavilla, T.L.; Gubser, D.V.; Wolf, S.A. pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B.H.; Turchi, P.J. IEEE Service Center, Piscataway, NJ (USA) (1987). DOE Contract AC04-76DP00789. (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

Recent developments in superconducting materials should be of interest to the pulsed power community. Niobium Nitride films have been made which can carry high currents (~10 MA/cm^2) in their superconducting state, yet which have a moderately high resistivity (~100 $\mu\omega$-cm) in their normal state. Laser light of moderate energy triggers the transition in nanoseconds. The new high-temperature oxide superconductors show promise of having similar critical current densities but higher normal-state resistivities (~1000 $\mu\omega$-cm). These properties raise the possibility of making a superconducting fast opening switch. In conjunction with superconducting inductive energy storage (~100 MJ/m^3), such a switch could provide the basis for very compact terawatt pulsed power generators. In this paper, the authors show some of the possible configurations, physical constraints, and scaling laws for such systems.

28775 Measuring the shielding effectiveness of superconductive composites. Pienkowski, T. (Belden Wire and Cable Technical Research Center, Geneva, IL (US)); Johnson, D.; Lanagan, M.T.; Poeppel, R.B.; Danyluk, S.; McGuire, M. pp. 446 of Proceedings of the IEEE 1989 national symposium on electromagnetic compatibility. IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890508–: IEEE international symposium on electromagnetic compatibility, Denver, CO (USA), 23-25 May 1989).

The ability to cool superconductors with liquid nitrogen instead of liquid helium has opened the door to a wide range of research. The Meissner effect, which states superconductors are perfectly diamagnetic, suggests shielding applications. One of the drawbacks to the new ceramic superconductors is the brittleness of the finished material. Because of this drawback any application which required any flexibility would be impractical. Therefore, this paper presents the results of a preliminary investigation into the measuring of shielding effectiveness of $YBa_2Cu_3O_{7-x}$ both as a composite and as a monolithic material. A flanged coaxial test fixture was selected to measure the shielding. The composite samples showed little or no shielding. The monolithic sample showed substantially less shielding then predicted. Possible explanations for this lack of shielding are discussed.

28776 High power density generator concepts for aerospace electric power. Hawsey, R.A. (Oak Ridge National Lab., Applied Technology Div., Oak Ridge, TN (US)); Bailey, J.M.; Allington, W.J.; McGrath, S.V.; Sartory, W.K.; Simmons, C.M.; Thomas, R.J.; Young, R.W. pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 2. IEEE Service Center, Piscataway, NJ (USA) (1989). DOE Contract AC05-84OR21400. (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899328.

The authors extended the concept of an axial field motor or of a printed circuit motor to special purpose permanent magnet generators operating at power levels of interest in the aerospace industry. A parametric design study for high power density electric generators was performed to assess the merits of the axial gap approach developed at the Oak Ridge National Laboratory. Rotor plate stress calculations, thermal analyses, and shaft and bearing evaluations were performed with generator speed and power levels as the primary variables. The speed range of 3,000 to 100,000 rpm and power levels from 10 to 1000 kW were taken as bounds for the study. Parametric curves suggest that generators in the 1-MW-output class may be constructed with specific weights <0.1 kg/kW. Innovative cooling methods and insulation considerations are presented.

28777 High-intensity subpicosecond XeCl laser system. Taylor, A.J. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Tallman, C.R.; Roberts, J.P.; Lester, C.S.; Gosnell, T.R.; Lee, P.H.Y.; Kyrala, G. *Optics Letters (USA)*, 15(1): 39-41 (1 Jan 1990).

A terawatt-class laser, based on the amplification of subpicosecond pulses in XeCl discharge amplifiers, is described. The system generates 250-mJ, 335-fsec pulses at a sustained 1-Hz repetition rate. Using *f*/3.7 optics, focal-spot dimensions of 3.4 μm x 4.1 μm are measured for the fully amplified output beam, thus demonstrating a mean focal-volume intensity of 4.6 x 10^{18} W/cm^2. With *f*/1 optics, this system is therefore capable of producing a focused intensity of 6.4 x 10^{19} W/cm^2.

28778 High-frequency acousto-optic mode locker for picosecond pulse generation. Keller, U. (Ginzton Laboratory, Stanford University, Stanford, California 94305 (USA)); Li, K.D.; Khuri-Yakub, P.T.; Bloom, D.; Gerstenberger, D.C.; Weingarten, K.J. *Optics Letters (USA)*, 15(1): 45-47 (1 Jan 1990). DOE Contract AC03-88ER80653.

We modeled, designed, and built a 500-MHz acousto-optic mode locker with a diffraction efficiency of 28% per 1 W drive power. The transducer is zinc oxide sputtered onto a sapphire substrate. A new figure of merit is defined for the mode-locker design, which indicates that sapphire is a good substrate material. Pulse widths of less than 10 psec with an average power of 150 mW were achieved from a 500-MHz pulse-rate, diode-pumped, cw mode-locked Nd:YLF laser using a pump power of 700 mW.

28779 Prebunching in a collective Raman free-electron laser amplifier. Wurtele, J.S. (Department of Physics, Research Laboratory of Electronics, and Plasma Fusion Center—Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (USA)); Bekefi, G.; Chu, R.; Xu, K. *Physics of Fluids B (USA)*, 2(2): 401-406 (Feb 1990).

Experiments, theory, and simulations are reported on the effects of electron prebunching in a mildly relativistic, low-current (200 kV, 1 A) free-electron laser amplifier operating in the collective (Raman) regime at a frequency of ~10 GHz. Prebunching is established by injecting an electromagnetic wave into a bifilar helical wiggler and then transporting the bunched beam into a second magnetic wiggler region. The wave growth rate, $\Gamma \equiv (1/P)(dP/dz)$, is deduced from measurements of the radiation intensity as a function of interaction length. Observations show that prebunching can increase the radiation growth rate Γ manyfold as compared with a system without prebunching.

28780 Ceramic fabrication processes for high-T_c superconductors. Poeppel, R.B. (Argonne National Lab., IL (USA). Materials and Components Technology Div.); Goretta, K.C.; Lanagan, M.T.; Dusek, J.T.; Degener, J.K. *Proceedings of the American Power Conference (USA)*, 50: 450-453 (1988). (CONF-880403–: American power conference, Chicago, IL (USA), 18-20 Apr 1988).

Several ceramics are known to be superconductors above the temperature of liquid nitrogen. Conventional ceramic processing techniques can be used to fabricate each of these ceramics into useful conductors. A common and versatile means of forming monofilament conductors is to mix superconductor powder with plastics, and then form the plastic mass into the desired shape. Post-forming heat treatment burns off the plastics and yields dense final products. The constituents of the plastic mix, and the forming and firing processes used to fabricate $YBa_2Cu_3O_{7-x}$ superconductors are discusses.

28781 Pressure drop measurements on supercritical helium cooled cable in conduit conductors. Daugherty, M.A. (Wisconsin Univ., Madison, WI (USA). Applied Superconductivity Center); Huang, Y.; Van Sciver, S.W. *IEEE Transactions on Magnetics (Institute of Electrical and Electronics Engineers) (USA)*, 25(2):

1512-1515 (Mar 1989). (CONF-880812--: Applied superconductivity conference, San Francisco, CA (USA), 21-25 Aug 1988).

Forced flow cable-in-conduit conductors with large cooled surface areas provide excellent stability margins at the price of high frictional losses and large pumping power requirements. For extensive projects such as the International Thermonuclear Experimental Reactor design cooperation it is essential to know the pressure drops to be expected from different conductor geometries and operating conditions. To measure these pressure drops a flow loop was constructed to circulate supercritical helium through different conductors. The loop is surrounded by a 5 K radiation shield to allow for stable operation at the required temperatures. A coil heat exchanger immersed in a helium bath is used to remove the heat generated by the pump. Pressure drops are measured across 1 meter lengths of the conductors for various mass flow rates. Friction factor versus Reynolds number plots are used to correlate the data.

28782 Electrochemically enhanced high T_c superconductor single-crystal flux growth. Garzon, F. (Los Alamos National Lab., Electronics Research Group, Los Alamos, NM (US)); Raistrick, I. *Journal of the Electrochemical Society (USA)*, 136(9): 2753 (Sep 1989).

Attempts to raise the oxygen content of the single crystals by oxygen annealing are hampered by low oxygen diffusivity in the crystals and microcracking from the strain induced by the orthorhombic to tetragonal transformation. The low oxygen content of these single crystals is not surprising, as they are usually grown from melts containing excess cupric oxide at temperatures above 850°C. It is likely that crystals nucleated and grown beneath the melt surface pressure because the melt will probably not be at equilibrium with the atmosphere. The elevation of the oxygen activity in the crystal growth medium is a promising method of directly producing orthorhombic single crystals. The authors report how they have achieved this by electrochemical transport of oxygen into the melts using an inert yttria-stabilized-zirconia solid electrolyte. The equilibrium electrode potential difference across a zirconia electrolyte separating two compartments with different oxygen activities, and operating within the electrolyte domain is described by the Nernst equation.

28783 Epoxy-encapsulated ceramic superconductor microelectrodes. Gollmor, R.O. (Kenan Labs., Univ. of North Carolina, Chapel Hill, NC (US)); McDevitt, J.T.; Murray, R.W.; Collman, J.P.; Yee, G.T.; Little, W.A. *Journal of the Electrochemical Society (USA)*, 136(12): 3696-1700 (Dec 1989).

A procedure is outlined for fabricating well-behaved microelectrodes from ceramic pellets of $YBa_2CU_3O_7$ and $Bi_2Sr_2CaCu_2O_8$ which involves systematic polishing of an epoxy-encapsulated superconductror chip, under Et_4NClO_4/acetonitrile solution, to a potentiometric end point. Voltammetry of the resulting microelectrodes in acetronitrile is illustrated and compared to that arising from alternative superconductor electrode geometries. The microelectrodes have active electrode surface areas ranging from 2 x 10 $^{-sup6}$ to 3 x 10 $^{-sup4}cm^2$, as characterized electrochemically and microscopically. The results discussed herein are steps toward developing the methodology necessary to study the electrochemical response of high temperature superconductor phases at temperatures below theirtheir superconductor critical temperature.

28784 Electrolytic cell with reference electrode. Kessie, R.W. To U.S. Dept. of Energy, Washington, DC. USA Patent 4888102/A/. 19 Dec 1989. Filed date 28 Jul 1988. USA Patent Application 7-225,411. Int. Cl. C25C 3/34. vp.

This patent describes an electrolytic cell. It comprises: a housing, an anode, cathode and reference electrode and is adapted to contain a molten-salt electrolyte above the anode. The reference electrode comprises an elongated glass tube of one-piece construction extending from the housing into the interior of the cell and having a lower closed-ended section with ionic conductivity, a metal electrode supported in the glass tube and in Separated juxtaposition with the closed end, an electrolyte in the lower section in contact with the electrode and an electrical insulator physically Separating the electrode and glass tube; an elongated metal tube extending from the housing over the glass tube as a protective cover and basket. The metal tube has a perforated side wall adapted to be in contact with the cell electrolyte and being closed-ended with respect to collecting any broken glass from the glass tube so as to act as a basket to minimize the amount of broken glass from otherwise falling through the electrolyte into the anode; means for supporting the glass tube within the metal tube and means supporting the metal tube in the cell housing.

28785 Laser particle sorter. Martin, J.C.; Buican, T.N. To U.S. Dept. of Energy, Washington, DC. USA Patent 4887721/A/. 19 Dec 1989. Filed date 30 Nov 1987. USA Patent Application 7-126,156. Int. Cl. B07C 5/342. vp.

This patent describes a method for sorting selected particles from a variety of particles in a flow stream. It comprises: radiatively propelling the variety of particles along a propulsion path; irradiating the particles with a probe laser beam to derive an output signal functionally related to a preselected characteristic in ones of the variety of particles; and radiatively deflecting the particles with the preselected characteristic along a deflection path intersecting the propulsion path.

28786 Spark gap-switch with spiral gas flow. Brucker, J.P. To U.S. Dept. of Energy, Washington, D.C. USA Patent 4886993/A/. 12 Dec 1989. Filed date 23 Mar 1988. USA Patent Application 7-172,096. Int. Cl. H01J 17/26. vp.

This patent describes a spark gap switch having first and second axially aligned electrodes spaced apart in a sealed housing and a contaminate removal system using an injected gas. It comprises: an annular plate concentric with the first electrode and defining vee-shaped peripheral grooves from the injected gas effective to form a spiral flow of the gas in the housing; and means for removing the gas from the housing.

28787 Overpulse railgun energy recovery circuit. Honig, E.M. To United States Dept. of Energy, Washington, DC. USA Patent 4885974/A/. 12 Dec 1989. Filed date 28 Sep 1984. USA Patent Application 6-655,593. Int. Cl. F41F 1/02. vp.

This patent describes an overpulse railgun energy recovery circuit for propelling a projectile along a railgun. The overpulse rail gun energy recovery circuit comprising: a railgun having an effective inductance, the railgun having a breach end, a pair of parallel rails, and a muzzle end; source inductor for storing current connected across the pair of parallel rails of the railgun at the breech end thereof; means for initially charging the source inductor to an initial current for storage; switching means connected across the source inductor with a closed position for shorting across the source inductor and an open position for enabling current flow into the effective inductance of the breech end towards the muzzle end of the railgun; a muzzle switch connected across the pair of parallel rails of the railgun at the muzzle end thereof; and transfer capacitive means.

28788 Wire inhomogeneity detector having a core with opposing pole pieces and guide pieces adjacent the opposing pole pieces. Gibson, G.H.; Smits, R.G.; Eberhard, P.H. To Dept. of Energy, Washington, DC. USA Patent 4864236/A/. 5 Sep 1989. Filed date 31 Aug 1982. USA Patent Application 6-413,589. Int. Cl. GOIN 27/72. vp.

This patent describes a wire inhomogeneity detector assembly for detecting changes in the conductive properties of a wire as the wire is passed therethrough. It comprises: a coil assembly through which a wire containing conductive material is adapted to be pressed in a direction substantially perpendicular to a longitudinal axis of the coil assembly. The coil assembly comprising a single ferrite core having a pair of opposing pole pieces between which are an associated conductive wire to be tested is adapted to be passed, each of the pole pieces having a coil wound therearound. The coil assembly including a guide-block consisting of a pair of guide pieces mounted adjacent to ends of the opposing pole pieces for guiding an associated conductive wire between the pole pieces and for reducing stray magnetic field lines. The guide pieces being positioned closely adjacent an associated conductive wire passing therebetween; an impedance bridge adjusted to an null balance point operatively connected to the coil assembly which measures the impedance of the coil assembly and is unbalanced by changes in eddy currents generated in the coil assembly; and a filter detector alarm assembly operatively connected to an output of

the impedance bridge. The filter detector alarm assembly including an input bandpass filter detector alarm assembly including an input bandpass filter operatively connected to a differential comparator, the output of which triggers an alarm.

28789 **Superconducting transmission line particle detector.** Gray, K.E. To Dept. of Energy, Washington, DC. USA Patent 4873482/A/. 10 Oct 1989. Filed date 28 Jul 1988. USA Patent Application 7-225,412. Int. Cl. G01N 27/00. 10p.

This paper describes a microvertex particle detector for use in a high energy physic collider including a plurality of parallel superconducting thin film strips separated from a superconducting ground plane by an insulating layer to form a plurality of superconducting waveguides. The microvertex particle detector indicates passage of a charged subatomic particle by measuring a voltage pulse measured across a superconducting waveguide caused by the transition of the superconducting thin film strip from a superconducting to a non-superconducting state in response to the passage of a charged particle. A plurality of superconducting thin film strips in two orthogonal planes plus the slow electromagnetic wave propogating in a superconducting transmission line are used to resolve N^2 ambiguity of charged particle events.

28790 **Detection of surface impurity phases in high T superconductors using thermally stimulated luminescence.** Cooke, D.W.; Jahan, M.S. To Dept. of Energy, Washington, DC. USA Patent 4873444/A/. 10 Oct 1989. Filed date 23 Nov 1988. USA Patent Application 7-276,188. Int. Cl. G01N 23/00. 8p.

This patent describes the detection of surface impurity phases in high-temperature superconducting materials. Thermally stimulated luminescence has been found to occur in insulating impurity phases which commonly exist in high-temperature superconducting materials. The present invention is sensitive to impurity phases occurring at a level of less than 1% with a probe depth of about 1 μm which is the region of interest for many superconductivity applications. Spectroscopic and spatial resolution of the emitted light from a sample permits identification and location of the impurity species. Absence of luminescence, and thus of insulating phases, can be correlated with low values of rf surface resistance.

28791 **X-ray beamsplitter.** Ceglio, N.M.; Stearns, D.S.; Hawryluk, A.M.; Barbee, T.W. Jr. To Dept. of Energy, Washington, DC. USA Patent 4870648/A/. 26 Sep 1989. Filed date 7 Aug 1987. USA Patent Application 7-082,468/A/. Int. Cl. H01S 3/08. 8p.

This patent describes an x-ray beamsplitter which splits an x-ray beam into two coherent parts by reflecting and transmitting some fraction of an incident beam has applications for x-ray interferometry, x-ray holography, x-ray beam manipulation, and x-ray laser cavity output couplers. The beamsplitter is formed of a wavelength selective multilayer thin film supported by a very thin x-ray transparent membrane. The beamsplitter resonantly transmits and reflects x-rays through thin film interference effects. A thin film is formed of 5-50 pairs of alternate Mo/Si layers with a period of 20-250 A. The support membrane is 10-200 nm of silicon nitride or boron nitride. The multilayer/support membrane structure is formed across a window in a substrate by first forming the structure on a solid substrate and then forming a window in the substrate to leave a free-standing structure over the window.

43 PARTICLE ACCELERATORS

Refer also to citation(s) 29394, 29395, 29397, 29398, 29399, 29400, 29401, 29402, 29408, 29439

28792 (NAC-AR–86-01) **Annual report June 1986.** National Accelerator Centre, Faure (South Africa). 1986. 282p. Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The design value of 250 kV for the dee voltage in the separated sector cyclotron (SSC) has been attained. The vacuum system, the diagnostic equipment and the injection system of the SSC perform according to expectation. During the year protons of different energies, as well as deuterons and helium ions, were successfully accelerated in the injector cyclotron (SPC1). The isocentric system for neutron therapy was installed, radiobiology laboratories were equipped, facilities for radioisotope production and bio-evaluation were prepared and orders were placed for a polarized ion source, an ECR source for heavy ions, major components for the second injector (SPC2) as well as various components for a magnetic spectrometer. Shielding was built up around beamlines and target areas while radiation safety procedures were finalised and implemented. Potential users were invited to submit proposals for research projects when external beams become available, hopefully towards the end of 1986. The Pretoria cyclotron has had to undergo a major overhaul after another ten years' of operation. During the rest of the year the production of radioisotopes and their supply to many local hospitals continued while further efforts were made to improve the quality, intensity and reliability of the external beam to make it suitable for neutron therapy. The Van de Graaff accelerator continued to run well and serve a large number of users from all over the country in a broadly based experimental programme. 5 figs.

4301 Design, Development, and Operation

Refer also to citation(s) 27770, 28677, 28882, 29135, 29394, 29395, 29396, 29397, 29398, 29399, 29400, 29401, 29413, 29414, 29415, 29416, 29419, 29420, 29425, 29426, 29428, 29429, 29430, 29431, 29432, 29433, 29438, 29440, 29441, 29442, 29443, 29444, 29508, 29513

28793 (FNAL-TM–1611) **Design note of a 10,000 amp 2 MJoules dump resistor for the magnet test facility.** Visser, A.T. Fermi National Accelerator Lab., Batavia, IL (USA). Mar 1990. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE90010161. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report contains the design notes of a 2 MJoules 10,000A, 1000V, dump resistor, with taps from 25 mOhms to 300 mOhms maximum. The resistor is forced air-cooled and can handle continuously one 2 MJ dump every 5 minutes at all taps. The resistor is made from 304 stainless steel bars and is mounted in a 90 in.H x 24 in.W x 20 in.D steel enclosure, with easy access to taps. The upper resistance sections are made lighter to save material cost and weight. The total weight of the resistance element is 427 lbs. The resistor is used to absorb the stored energy from cryogenic magnets during tests at the magnet test facility. Interlocks are provided for remote tap readout, dc over current and over temperature. A build-in current sensor and timing relay switch forced air-cooling on for 5 minutes, after a dump. 12 figs., 3 tabs.

28794 (FNAL-TM–1651) **Mechanical support for straw tubes.** Joestlein, H. Fermi National Accelerator Lab., Batavia, IL (USA). 11 Mar 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE90008181. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A design is proposed for mounting a large number of straw tubes to form an SSC central tracking chamber. The assembly is precise and of very low mass. The fabrication is modular and can be carried out with a minimum of tooling and instrumentation. Testing of modules is possible prior to the final assembly. 4 figs.

28795 (FNAL-TM–1653) **Conceptual design for the SSC high energy booster.** Nicol, T.H.; Harfoush, F.A.; Harrison, M.A.; Kerby, J.S.; Koepke, K.P.; Mantsch, P.M.; Peterson, T.J.; Riddiford, A.W. Fermi National Accelerator Lab., Batavia, IL (USA). Mar 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-900348–1: 2. international industrial symposium on the super collider, Miami, FL (USA), 14-16 Mar 1990). Order Number DE90008183. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A tremendous amount of work has been done over the course of the past several years on the design of dipole magnets for the SSC main collider. Although they dominate the total magnet cost for the project and thus deserve the tremendous research and development effort they have received, the main ring magnets represent only part of the magnet requirements for the SSC. This paper presents the work to date on the design of dipole magnets for the SSC high energy booster (HEB). A complete discussion of the design is beyond the scope of this work. Rather it serves as an

overview of the main aspects of the complete design. 4 refs., 7 figs.

28796 (LA–11684-C-Vol.1) **Proceedings of the Advanced Hadron Facility accelerator design workshop, February 20–25, 1989: Volume 1.** Thiessen, H.A. (comp.). Los Alamos National Lab., NM (USA). Apr 1990. 461p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-890299–Vol.1: 1989 Advanced Hadron Facility accelerator design workshop, Los Alamos, NM (USA), 20-25 Feb 1989). Order Number DE90010235. Available from NTIS, PC A20/MF A01; OSTI; INIS; GPO Dep.

The International Workshop on Hadron Facility Technology was held February 20–25, 1989, at the Study Center at Los Alamos National Laboratory. This volume (first of two) included papers on architecture, beam diagnostics, compressors, and linacs. Participants included groups from AHF, Brookhaven National Laboratory, European Hadron Facility, Fermilab, and the Moscow Meson Factory. The workshop was well attended by members of the Los Alamos staff. The interchange of information and the opportunity by criticism by peers was important to all who attended.

28797 (LA–11684-C-Vol.2) **Proceedings of the Advanced Hadron Facility accelerator design workshop, February 20–25, 1989: Volume 2.** Thiessen, H.A. (comp.). Los Alamos National Lab., NM (USA). Apr 1990. 460p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-890299–Vol.2: 1989 Advanced Hadron Facility accelerator design workshop, Los Alamos, NM (USA), 20-25 Feb 1989). Order Number DE90010237. Available from NTIS, PC A20/MF A01; OSTI; INIS; GPO Dep.

The International Workshop on Hadron Facility Technology was held February 20–25, 1989, at the Study Center at Los Alamos National Laboratory. This volume (second of two) included papers on computer controls, polarized beam, rf, magnet and power supplies, experimental areas, and instabilities. Participants included groups from AHF, Brookhaven National Laboratory, European Hadron Facility, Fermilab, and the Moscow Meson Factory. The workshop was well attended by members of the Los Alamos staff. The interchange of information and the opportunity by criticism by peers was important to all who attended.

28798 (NAC-AR–86-01, pp. 95-99) **The control system.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The hardware of the NAC control system consists of a number of 16-bit minicomputers, 8-bit microcomputers, the CAMAC network known as the Executive or System Crate system, and control consoles connected to the minicomputers by CAMAC parallel branches. Activities during the last year have concentrated on the further interfacing to the control system of the accelerator, specifically the separated-sector cyclotron (SSC) and the high-energy beamlines, on increasing the reliability of the control system, and on microprocessor activities which include the manufacture of vacuum control systems, local control systems for stepping motors and for an rf-system, a microcomputer-based current measuring system, and the fabrication and implementation of a modified interlocking system and area-clear monitors. 2 refs.

28799 (NAC-AR–86-01, pp. 132-139) **Mechanical engineering.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The major design work which received attention over the year was: the SSC injection and extraction collimators; the EP1 and EP2 probes; the septum magnet SPM2; the buncher; heads for the multi-head probes; supports for switching magnets; beam stops for the experimental beamlines; and a rotary target-handling system for isotope production. The major components that were manufactured, tested and installed during the past year were: the injection and extraction collimators; septum magnet SPM1 inside the SSC resonator; septum magnet SPM2 on the SSC extraction valley chamber; the electrostatic extraction channel on the SSC injection valley chamber; multi-head probes for the SSC; the high-energy beamline cooling water distribution system; the pneumatic system for the high-energy beamline diagnostic equipment; braces between SSC magnets; and axial graphite collimators. 5 figs.

28800 (NAC-AR–86-01, pp. 140-147) **Electrical engineering.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The position control ekectronics for 12 slit systems in the high-energy beamline has been completed and tested. Two versions of a temperature-sensing and alarm system have been completed, providing temperature checks at 131 and 22 points respectively, in the SSC. Other items constructed and installed include a stepping motor position controller test unit, 14 position control units for the SSC, and the first of four control units for the short-circuit plates of the SSC resonators. 6 figs.

28801 (NAC-AR–86-01, pp. 190) **The 6 MV Van De Graaff accelerator.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Short note. VAN DE GRAAFF ACCELERATORS/maintenance; VAN DE GRAAFF ACCELERATORS/operation; ION BEAMS; MEV RANGE 01-10; MEV RANGE 10-100; NAC CYCLOTRON; NEUTRONS; PROGRESS REPORT; MAINTENANCE; OPERATION

28802 Participation of SAIC (Science Applications International Corporation) in the LLUMC (Loma Linda University Medical Center) proton synchrotron project. Prichard, B.A. Jr. (Science Applications International Corp., Princeton, NJ (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Loma Linda University Medical Center (LLUMC) is constructing a 250 MeV proton synchrotron and associated treatment facilities for the purpose of the control of cancer through particle beam irradiation or proton therapy. The synchrotron and beam transport line are being developed by Fermi National Accelerator Laboratory (FNAL) with participation by Science Applications International Corporation (SAIC) as an industrial partner for technology transfer. SAIC is supporting the project in three ways: (1) by accomplishing specific tasks in the design and development of the facility; (2) by participating directly with LLUMC and FNAL in areas of technology transfer; and (3) by being directly responsible for the installation, commissioning, and early operation of the facility. 2 refs., 5 figs., 2 tabs.

28803 Performance of full-length SCC model dipoles: Results from 1988 tests. Tompkins, J.; Chapman, M.; Cortella, J.; Desportes, A.; Devred, A.; Kaugerts, J.; Kirk, T.; Mirk, K.; Schermer, R.; Turner, J. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Over the past year, magnets that meet the SSC field and quench training criteria have been developed as a result of the detailed understanding of magnet performance made possible by tests on a series of model magnets. The SSC dipole magnet design is a $\cos\theta$ style coil with a 4-cm aperture and a magnetic length of 16.6 m. The design operating field is 6.6 T at a current of 6.5 kVA. Design, fabrication, and testing of full-length model magnets has been a cooperative effort among the SSC Central Design group and three major national laboratories: BNL, FNAL, and LBL. 13 refs., 7 figs., 1 tab.

28804 SSC dipole coil production tooling. Carson, J.A. (Fermi National Accelerator Lab., Batavia, IL (USA)); Barczak, E.J.; Bossert, R.C.; Brandt, J.S.; Smith, G.A. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Superconducting Super Collider dipole coils must be produced to high precision to ensure uniform prestress and even conductor distribution within the collared coil assembly. Tooling is being prepared at Fermilab for the production of high precision 1M and 16.6M SSC dipole coils suitable for mass production. The design and construction methods builds on the Tevatron tooling and production experience. Details of the design and construction methods and measured coil uniformity of 1M coils will be presented. 4 refs., 10 figs.

28805 Tunneling technologies for the collider ring tunnels. Frobenius, P. (Bechtel Civil, Inc., San Francisco, CA (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The Texas site chosen for the Superconducting Super Collider has been studied, and it has been determined that proven, conventional technology and accepted engineering practice are suitable for constructing the collider tunnels. The Texas National Research Laboratory Commission report recommended that two types of tunneling machines be used for construction of the tunnels: a conventional hard rock tunnel boring machine (TBM) for the Austin chalk and a double shielded, rotary TBM for the Taylor marl. Since the tunneling machines usually set the pace for the project, efficient planning, operation, and coordination of the tunneling system components will be critical to the schedule and cost of the project. During design, tunneling rate prediction should be refined by focusing on the development of an effective tunneling system and evaluating its capacity to meet or exceed the required schedules. 8 refs., 13 figs.

28806 High performance proton accelerators. Favale, A.J. (Grumman Space Systems, Bethpage, NY (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

In concert with this theme this paper briefly outlines how Grumman, over the past 4 years, has evolved from a company that designed and fabricated a Radio Frequency Quadrupole (RFQ) accelerator from the Los Alamos National Laboratory (LANL) physics and specifications to a company who, as prime contractor, is designing, fabricating, assembling and commissioning the US Army Strategic Defense Commands (USA SDC) Continuous Wave Deuterium Demonstrator (CWDD) accelerator as a turn-key operation. In the case of the RFQ, LANL scientists performed the physics analysis, established the specifications supported Grumman on the mechanical design, conducted the RFQ tuning and tested the RFQ at their laboratory. For the CWDD Program Grumman has the responsibility for the physics and engineering designs, assembly, testing and commissioning albeit with the support of consultants from LANL, Lawrence Berkeley Laboratory (LBL) and Brookhaven National laboratory. In addition, Culham Laboratory and LANL are team members on CWDD. LANL scientists have reviewed the physics design as well as a USA SDC review board. 9 figs.

28807 Construction techniques used at CERN (European Laboratory for Particle Physics) for the LEP (large electron positron) project. Laughton, C. (Lawrence Berkeley Lab., CA (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The Large Electron Positron (LEP) machine was selected by the European Committee for Future Accelerators (ECFA) in the 1970s as the machine best suited to achieving the next step forward in high-energy physics research. LEP is a natural forerunner to the Superconducting Super Collider, having a similar layout and operating strategy. The LEP accelerator is located adjacent to existing European Laboratory for Particle Physics (CERN) facilities in the Leman Basin astride the French-Swiss border near Geneva. The site allows CERN laboratory accelerators to be used for the pre-acceleration and injection of the electrons and positrons into the LEP ring, with the construction of the main tunnel and experimental halls in competent rock structures, avoiding overlying moraine or till deposits and deep excavation under the water table. The LEP machine evolved considerably from conception to construction as cost and risk factors were taken into account in fixing the final site dimensions and orientation. A balance was struck between construction costs and operational power consumption, which is reduced with an increase in the rings radius of curvature. This paper describes the siting and execution of the LEP underground works. 3 refs., 16 figs.

28808 Critical issues concerning tunnel ventilation in the super conducting super collider ring tunnel. Egilsrud, P.E. (Sverdrup Corp., St. Louis, MO (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

In this paper, the author discusses the problem of designing a ventilation system for the SSC Collider Ring Tunnel. The history of ventilation of tunnels is briefly reviewed and the types of systems used for ventilation of rail, transit and highway tunnels are described in detail. Next, the ventilation system prepared for the Collider Ring Tunnel in the RTK conceptual conventional design report is described. The author questions this design from a safety and practical standpoint. He offers several other solutions which provided a more powerful system for emergencies. One supplies fresh outside air uniformly along the tunnel length. All suggested systems increase costs over the RTK proposed system. The possible problem of troublesome condensation forming on equipment in the tunnel and tunnel walls in hot, humid weather is also a major concern. 5 figs.

28809 Impact of radiation shielding requirements on conventional construction for the SSC. Doddy, G.J. (Daniel, Mann, Johnson and Mendenhall, Washington, DC (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The purpose of the conventional facilities in an accelerator is to support the technical components of the accelerator and this is particularly true in the case of the radiation shielding. Because of the vast parameters of the SSC, the requirement for shielding protection will have a corresponding impact in the design and construction of the conventional facilities. The intent of this paper, therefore, is to review the sources of radiation in lay terms and to address the areas where protection is required in general terms. The first 4 accelerators comprise the injector which introduces two 1 TeV proton beams in opposite directions into the collider which then accelerates and stores these proton beams at 20 TeV in preparation for the collisions in the interaction regions of the experimental areas with a total energy level of 40 TeV. The accelerators which contain the magnets, the interaction regions which contain the detectors and the beam aborts systems which contain the beam dumps are the sources of radiation and are located in tunnels and underground enclosures which must be designed to accommodate the respective sources and types of radiation. 19 refs., 14 figs.

28810 Development of new scintillating materials for the SSC. Hurlbut, C.R. (Bicron Corp., Newbury, OH (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Development of organic scintillators for the SSC is concentrated in the two areas of scintillating optical fibers and resistance to radiation damage. While good progress has been made in adapting small-scale fiber making methods to the conventional plastic scintillator technology, much work remains in optimizing light output and transmission in small fibers and in mass production techniques. New solvent and fluor systems are being investigated for liquid fiber optics, and novel polymers are being tried for greater rad-hardness. The greatest challenge is the radiation damage issue. Systematic research is building a base for postulating damage mechanisms and how scintillators should be utilized in high intensity radiation fields. 7 refs., 9 figs.

28811 Systems engineering and integrated for the SSC. Laintz, D.J. (Martin Marietta Astronautics, Denver, CO (USA)); Crosby, B.; Davis, M.; Eben, D.; Gliozzi, J.; Kientz, E.; Knafelc, J.; Phelps, J.; Rider, M.; Shearer, K. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Experience in high technology projects of scale and scope similar to the SSC, leads the authors to propose utilization of a Systems Engineering and Integration (SE and I) process tailored specifically to the SSC project. They begin by giving an overview of SE and I. This overview includes the purpose, history, definition, and a discussion of when to use it. They then proceeded to give a description of a formalized SE and I process. They discuss tailoring

the process to a project and close by recommending an early commitment to an SE and I methodology for the SSC. 2 refs., 2 figs.

28812 Development of radhard VLSI electronics for SSC calorimeters. Dawson, J.W. (Argonne National Lab., IL (USA)); Nodulman, L.J. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

A new program of development of integrated electronics for liquid argon calorimeters in the SSC detector environment is being started at Argonne National Laboratory. Scientists from Brookhaven National Laboratory and Vanderbilt University together with an industrial participant are expected to collaborate in this work. Interaction rates, segmentation, and the radiation environment dictate that front-end electronics of SSC calorimeters must be implemented in the form of highly integrated, radhard, analog, low-noise, VLSI custom monolithic devices. Important considerations are power dissipation, choice of functions integrated on the front-end chips, and cabling requirements. An extensive level of expertise in radhard electronics exists within the industrial community, and a primary objective of this work is to bring that expertise to bear on the problems of SSC detector design. Radiation hardness measurements and requirements as well as calorimeter design will be primarily the responsibility of Argonne scientists and their Brookhaven and Vanderbilt colleagues. Radhard VLSI design and fabrication will be primarily the industrial participants responsibility. The rapid-cycling synchrotron at Argonne will be used for radiation damage studies involving response to neutrons and charged particles, while damage from gammas will be investigated at Brookhaven. 10 refs., 6 figs., 2 tabs.

28813 Progress for SSC. Hong, S. (Oxford Superconducting Technology, Carteret, NJ (USA)); Geschwindner, D.; Mantone, A.; Marancik, W.; Zalek, S.; Zhou, R. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The charged particle beam in the accelerator is kept on its orbit by powerful dipole magnets. The dipole magnets for large accelerators are often made of superconductors for technical and economical reasons. Based on the technical success of the Tevatron, the proton synchrotron at the Fermi Accelerator Laboratory, the dipoles for the Superconducting Super Collider (SSC) are of high performance superconducting magnets. However, the SSC requires quite advanced superconducting composites compared to the Tevatron composites for economical reasons. The requirement of critical current density (J_c) is high. The Tevatron required ~1,800 A/mm^2 at 5 T and the SSC requires ~ 3,000 A/mm^2 at 5 T. This enhanced J_c requirement necessitates the finer filament diameter of superconductor in the composite to minimize the sextapole field errors due to the magnetization of filaments at the low injection field. For the industrial fabrication of this composite, the superconducting composite manufacturers in the US have been developing this composite for the past few years with close collaboration with national laboratories and universities. In this paper, they will review the progress for SSC superconducting composites developed at Oxford Superconducting Technology (OST). 3 figs.

28814 Superconducting wire and cable for the superconducting supercollider. Kreilick, T.S. (Supercon Inc., Shrewsbury, MA (USA)); Gregory, E.; Christopherson, D.; Swenson, G.P.; Wong, J. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

In the last few years the development of improved fine filamentary NbTi wires has been spurred on by the potential need for material to be used in the dipole and quadrupole magnets for the Superconducting SuperCollider (SSC). The result has been a substantial increase in the current carrying capacity of commercially available materials and a significant reduction in filament diameter. The manner in which these improvements have been achieved is outlined and the problems encountered discussed. The relative importance of factors such as homogeneity of the NbTi raw materials, heat treatment and cold work cycles, reaction between the matrix and the filaments, filament spacing and uniformity of the filament array, on the critical current density obtainable, are discussed. 20 refs., 6 figs., 3 tabs.

28815 An industrial cabling machine for the SSC. Royet, J. (Lawrence Berkeley Lab., CA (USA)); Armer, R.; Hannaford, R.; Scanlan, R. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). DOE Contract AC03-76SF00098. (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The SSC project will need the manufacturing of some 25,000 kilometers of keystoned flat cable. The technical specifications of the various cables to be produced are the result of 5 years of research and development work at LBL (Lawrence Berkeley Laboratory). An experimental cable machine was built and run in the laboratory; many improvements were implemented and tested. Semi-industrial production of the various cables was performed, and the resulting cable were used and tested in the one-meter model magnets and 17.5 meter dipole prototypes. From these experiments an industrial cabler specification was generated and used for an international RFQ. The winner of the contract is Dour Metal, a Belgium company that built the first industrial prototype which is now in a production line at New England Electric wire Company. In this paper they describe the main characteristics of the machine and give the first industrial production results of superconducting keystoned cable for the SSC project. 4 refs., 1 fig.

28816 Superconducting wire and cable for the SSC - Progress at intermagnetics general corporation towards production. Kanithi, H. (IGC Advanced Superconductors Inc., Waterbury, CT (USA)); Krahula, F.; Erdmann, M.; Schaedler, R.; Zeitlin, B. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The requirements of the SSC are examined from the point of view of a wire and cable manufacturer. The present status of the conductor development at IGC is described. Since the SSC will require a large volume production at the most economical price, billets measuring 12 inches in diameter have been used for prototype wire production. Both inner and outer grades of wire have been processed with NbTi filament diameters of 5 to 9 μm. Considerations of the production scale up that will have to be made to meet the demands of the SSC, are also discussed. A novel conductor design which promises to have greatly increased flux pinning capability and consequently can sustain significantly higher current densities than can conventional materials, is mentioned. 8 refs., 6 figs.

28817 Development of SSC cable in Furukawa. Ikeda, Masaru (Furukawa Electric Co., Ltd., Yokohama (Japan)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Furukawa Electric has been developing Rutherford cable to be used for the Superconducting Super Collider (SSC) Project in the US. The fabricated cable of approximately 15 km in length could meet all of the SSC specifications, and wound into SSC model dipole coils, which were successfully tested. In connection with development of the SSC cable, critical current degradations due to twisting, annealing and cabling were studied. It has been found that the cable annealed at an adequate condition has a higher RRR value and the cable having a large keystone angle of up to three degrees can be fabricated, without significant degradation. 4 figs., 3 tabs.

28818 Labarge liquid helium plant. Olson, R.R. Jr. (Union Carbide Industrial Gases Inc., Tonawanda, NY (USA)); Pahade, R.F. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

New applications for helium have resulted in a significant growth in helium demand. This growth has contributed to development of larger, more efficient liquid helium production plants. The liquid helium plant at LaBarge is sized for 4,600 liters per hour of liquid

helium production (dewar mass gain basis) using 2 purification/ liquefaction plant trains. A liquid nitrogen forecooled refrigerator having a power consumption similar to the liquefier cycle would provide about 10,000 watts of refrigeration at liquid helium temperature. Operating experience with liquid helium production facilities has demonstrated reliable commercial operation. 1 ref., 7 fig.

28819 An alternate end design for SSC dipoles. Peters, C. (Lawrence Berkeley Lab., CA (USA)); Caspi, S.; Taylor, C. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). DOE Contract AC03-76SF00098. (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Experience in the SSC dipole program has shown that fabrication of cylindrical coil ends is difficult. Cable stiffness requires large forces to maintain the proper position of the conductors in the end during winding. After winding, the coil ends remain distorted and significant motion of the end conductors is required to force the coil end into the molding cavity. Local mechanical stresses are high during this process and extra pieces of insulation are required to prevent turn-to-turn shorts from developing during the winding and molding steps. Prior to assembly the coil end is compressed in a mold cavity and injected with a filler material to correct surface irregularities and fill voids in the end. LBL has developed an alternate design which permits the conductors to be wound over the ends using minimal force and technician coersion. The conductors are placed on a conical surface where the largest diameter over the outer layer conductors is 10 cm. No coil end spaces or insulation pieces between turns are required. The conductor geometry was analytically optimized to meet SSC multipole requirements for the ends. The first 1-m dipole utilizing this end geometry has been constructed and successfully tested. Design and construction data are presented. Also, model test results, including training and multipole measurements of the end, are given. 1 ref., 12 figs., 3 tabs.

28820 Design principles for prototype and production magnetic measurements of superconducting magnets. Brown, B.C. (Fermi National Accelerator Lab., Batavia, IL (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The magnetic field strength and shape for SSC superconducting magnets will determine critical properties of the accelerator systems. This paper will enumerate the relations between magnetic field properties and magnet material selection and assembly techniques. Magnitudes of various field errors will be explored along with operating parameters which can affect them. Magnetic field quality requirements will be compared to available measuring techniques and the relation between magnetic field measurements and other quality control efforts will be discussed. This will provide a framework for designing a complete magnet measurement plant for the SSC project. 17 refs., 1 fig., 5 tabs.

28821 Review on the industrial fabrication of the superconducting HERA quadrupole coils. Krischel, D. (Interatom GmbH Accelerator and Magnet Technology, Gladbach (West Germany)); Boeer, J.; Fechteler, H.; Sommer, F. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The superconducting quadrupole coils for HERA had been developed and successfully tested as laboratory prototypes by CEN-Saclay under contract of DESY, Hamburg. The authors report on the fabrication under industrial conditions and on test results of collared preseries and series coils. Special emphasis is laid on the consequences resulting from slight but relevant changes in material properties for the series compared to the prototypes like mechanical tolerances, permeability, insulation thickness or sensitivity to temperature during curing. 1 ref., 5 figs., 1 tab.

28822 The effects of processing on the filament array in multifilament SSC strand. Valaris, P. (Supercon, Inc., Shrewsbury, MA (USA)); Kreilick, T.S.; Gregory, E.; Collings, E.W. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). DOE Contract AC01-87ER80437. (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Recent Supercon, Inc. investigations have been seeking to determine the extent to which processing affects the strand and its desired properties at the final wire size. The focus of this investigation is to determine the effects of processing in two main areas. The first being how the overall copper/copper-manganese to superconductor ratio changes due to processing. This was examined by the use of wet chemical analysis. The second being how the filament quality is affected by the selection of the spacing to diameter ratio (S/D) and the processing. These apparent effects are examined by the use of SEM-image analysis (SEM-IA) techniques. Such investigations enable the billet designer to compensate for expected processing effects. Wire from three billets is investigated and compared. 10 refs., 5 figs., 1 tab.

28823 SSC magnet mechanical interconnections. Bossert, R.C. (Fermi National Accelerator Lab., Batavia, IL (USA)); Niemann, R.C.; Carson, J.A.; Ramstein, W.L.; Reynolds, M.P.; Engler, N.H. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Installation of superconducting accelerator dipole and quadrupole magnets and spool pieces in the SSC tunnel requires the interconnection of the cryostats. The connections are both of an electrical and mechanical nature. The details of the mechanical connections are presented. The connections include piping, thermal shields and insulation. There are seven piping systems to be connected. These systems must carry cryogenic fluids at various pressures or maintain vacuum and must be consistently leak tight. The interconnection region must be able to expand and contract as magnets change in length while cooling and warming. The heat leak characteristics of the interconnection region must be comparable to that of the body of the magnet. Rapid assembly and disassembly is required. The magnet cryostat development program is discussed. Results of quality control testing are reported. Results of making full scale interconnections under magnet test situations are reviewed. 3 refs., 11 figs., 4 tabs.

28824 Multilayer insulation (MLI) in the superconducting super collider - A practical engineering approach to physical parameters governing MLI thermal performance. Gonczy, J.D. (Fermi National Accelerator Lab., Batavia, IL (USA)); Boroski, W.N.; Niemann, R.C. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Multilayer insulation (MLI) is employed in cryogenic devices to control the heat load of those devices. The physics defining the thermal performance of an MLI system is extremely complex due to the thermal dynamics of numerous interdependent parameter which in themselves contribute differently depending on whether boundary conditions are transient or steady-state. The Multilayer Insulation system for the Superconducting Super Collider (SSC) consists of full cryostat length assemblies of aluminized polyester film, fabricated in the form of blankets, and installed as blankets to the 4.5 K cold mass, and the 20K and 80K thermal radiation shields. Approximately 40,000 blankets will be required in the 10,000 cryogenic devices comprising the SSC accelerator. Each blanket will be nearly 56 feet long by 6 feet wide and will consist of as many as 32 reflective and 31 spacer layers of material. Discussed are MLI material choices, and the physical parameters which contribute to the operational performance of MLI systems. Disclosed is a method for fabricating MLI blankets by employing a large diameter winding mandrel having a circumference sufficient for the required blanket length. The blanket fabrication method assures consistency in mass produced MLI blankets by providing positive control of the dimensional parameters which contribute to the MLI blanket thermal performance. The fabrication method can be used to mass produce prefabricated MLI blankets that by virtue of the product have inherent features of dimensional stability, three-dimensional uniformity, controlled layer density, layer-to-layer

registration, interlayer cleanliness, and interlayer material to accommodate thermal contraction differences. 9 refs., 1 fig., 2 tabs.

28825 Status of suspension connection for SSC coil assembly. Larson, E.T. (Fermi National Accelerator Lab., Batavia (USA)); Nicol, T.H.; Niemann, R.C.; Zink, R.A. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Superconducting Super Collider dipole magnets require an integrated suspension system to meet the structural and thermal requirements outlined in the design criteria. Sliding suspension connections which retain the cold mass assembly during static and dynamic loading, while allowing axial motion during thermal contraction are an integral part of this magnet suspension system. Variations from the original prototype design have been tested and their performance compared. The results of these evaluations, and areas of future investigation are described. 7 refs., 7 figs.

28826 Advanced composite structures for superconducting super collider. Morris, V.L. (Structural Composites Industries (SCI), Pomona, CA (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Advanced composite structures are currently being utilized in numerous cryogenic systems. They offer low thermal conductivity, high strength and stiffness, lightweight, low outgassing, integral fittings, and other advantages. Several types of fibers and resins are available to meet extreme structural and thermal requirements. Typical properties for filament wound composite laminates are provided. Design considerations for various configurations, such as straps, tubes, and struts, are discussed. Typical applications are dewars for spacecraft, coolers for satellite instruments, and superconducting magnets for medical imaging and high-energy physics. The cryostat developed by Fermi National Accelerator Laboratory for the SSC dipole magnets has advanced composite support posts and anchor tie bars. 5 refs., 22 figs.

28827 Development of improved, radiation-resistant plastic and liquid scintillators for the SSC. Zorn, C. (Univ. of Florida, Gainesville (USA)); Bowen, M.; Majewski, S.; Szaban, J.; Wojcik, R.; Hurlbut, C.; Moser, W. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). DOE Contract FG05-86ER40272. (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

Plastic scintillators available on the market suffer from radiation damage at doses much lower than the ones expected at the SSC. The two major effects are induced transmission losses and damage to the scintillating fluors. The dominant radiation-induced absorption effects in the blue part of the transmission spectrum can be remedied by the use of large Stokes shift fluors emitting in the green region above 500 nm. With these fluors, the newly produced scintillators based on polyvinyltoluene and polystyrene have greatly enhanced radiation resistance. In cases when even the improved plastic scintillators will fail, liquid scintillators can be used. When damaged, the active material can be replaced without dismounting detector modules. Contrary to expectations, their tests showed that standard liquid formulations are damaged at rather low radiation doses of 1-5 Mrad. Newly developed formulations are significantly more radiation resistant. 20 refs., 10 figs.

28828 A high resolution barium fluoride crystal array. Zhu, Renyuan (California Institute of Technology, Pasadena (USA)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). DOE Contract AC03-81ER40050. (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

A high speed and highly radiation-resistant barium fluoride crystal array is under development at Caltech in collaboration with the Brookhaven National Lab, the Shanghai Institute of Ceramics in China, and the KEK in Japan. The barium fluoride array will serve as a prototype for a high precision electromagnetic calorimeter which is uniquely suitable for the Superconducting Super Collider, where high speed and radiation resistance up to 10 mega-Rads or greater doses are primary requirements. This research program aims at producing large size barium fluoride crystals with high radiation resistance, and developing a fast, effective light-sensitive readout to collect the fast scintillation components. Test results of commercially available barium fluoride and a test crystal produced at Shanghai are reported. 26 refs., 9 figs., 3 tabs.

28829 Recent development of the Cu/Nb-Ti superconducting cables for SSC in Hitachi Cable, Ltd. Sakai, S. (Hitachi Cable, Ltd., Ibaraki-ken (Japan)); Iwaki, G.; Sawada, Y.; Moriai, H.; Ishigami, Y. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

In these few years, Cu/Nb-Ti superconducting cables for the dipole magnets of SSC projects have been developed in the industrial scale in Hitachi Cable, Ltd. The features of these developed conductors are as follows. (1) The diameter of Nb-Ti filaments is very small, 4-6 μm. (2) The critical current density (J_c) is very high, 2,850-3,050 A/mm^2 at 5 T on wires, 2750-2950 A/mm^2 at 5 T on cables in industrial scale. The champion J_c of wires is 3,460 A/mm^2 at 5 T in the laboratory scale. (3) The RRR Residual Resistivity Ratio values of developed cables is very high, approximately 200, due to the newly developed high purity Oxygen Free Copper (OFC). (4) The conductors have been wound to the 1 m length dipole magnet in Hitachi Ltd., and it has generated 6.7 T in the central magnetic field at 6,595 A. The Cu/Cu-Mn/Nb-Ti composite wires which avoid the possibility of electrical coupling of the filaments have been produced in laboratory scale. The RRR of the copper stabilizer and J_c properties have not degraded because of no metallurgical reactions between Cu and Mn, Nb-Ti and Mn. 7 refs., 9 figs., 4 tabs.

28830 Industrial production of HERA superconducting dipoles. Gagliardi, P. (Ansaldo Componenti, Genoa (Italy)); Laurenti, A.; Martini, A.; Penco, R. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

More than 40% of the total production of 242 superconducting dipoles has been carried out. The tests at room and cryogenic temperature have shown very good results, even better than expected for industrial production of such products. The well-designed tooling and plants, the high professionalism of the technicians and the operators, and the good organization have permitted them to reach these results. 5 refs., 4 figs.

28831 Engineering and construction experience at LEP (CERN). Bachy, G. (CERN, Geneva (Switzerland)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

CERN's latest facility presently under construction is LEP. LEP consists of a ring located in an underground tunnel, 26.6 km long, 3.8 m in diameter and excavated between 50 and 150 m below the surface. The experience gained during the LEP project's engineering and construction/installation phase is multiple. The main features (all related to the size of the machine) appeared to the authors to be: a good analysis of contract splitting, minimization of costly underground work, maximization of prefabrication and standardization, use of a unique computerized source of information associated with modern CAD design tools, preparation of management tool before the start of installation and a suitable choice of underground transport system. 4 refs., 6 figs.

28832 Industrial experience on the HERA accelerator at DESY. Voss, G. (Deutsches Elektronen-Synchrotron DESY, Hamburg (West Germany)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

HERA is a unique new storage ring facility under construction at DESY, Hamburg. A 4-mile circular tunnel houses a 1 TeV proton storage ring. In the same tunnel is a 35 GeV electron storage ring. The counter-rotating proton and electron beams can be made to collide in four large underground halls. The project was authorized in April 1984. The electron ring started operation in August 1988.

First colliding beam experiments with protons and electrons are to start in 1990. Besides its unique technical features, HERA is also remarkable in other aspects: HERA is the first high energy accelerator to be built as a national facility but with large international contributions of equipment and labor. This paper discusses the industrial involvement in the HERA project.

28833 **Series production of the first 20 superconducting HERA dipole magnets at ABB.** Bonmann, D. (Asea Brown Boveri (ABB), Mannheim (West Germany)). pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

The HERA accelerator facility at Hamburg, FRG, which is presently under construction will obtain more than 400 superconducting dipole magnets of 9 m length. ABB has completed the preseries of 20 dipole magnets as part of a contract over the production of 215 standard dipoles and the design and production of 8 vertically deflecting dipoles. More than 120 collared coils have been built and are now assembled in their cryostats. The production steps leading from the collared coil to the finished dipole magnet and some of the essential quality assurance procedures are described. 5 refs., 7 figs.

28834 **S.C. magnet fabrication at Ansaldo.** Penco, R. (Ansaldo Componenti S.p.A., Genoa (Italy)); Laurenti, A.; Martini, A.; Valente, P. pp. 837 of Supercollider 1. McAshan, M. (ed.). Plenum Press, New York, NY (US) (1989). (CONF-890270–: International industrial symposium on the super collider, New Orleans, LA (USA), 8-10 Feb 1989).

During the presentation, a videotape about the HERA DIPOLE production was shown. The workshop, the tooling and all the operation sequences for the fabrication of the dipoles were described. You can find here below the technical part of the text of that record. Ansaldo Componenti is building 242 superconducting dipoles for the INFN (National Institute for Nuclear Physics). These dipoles have been designed to deflect the neutron beam in the 820 GeV, 6.3 km circumference HERA particle accelerator for protons and electrons at the DESY laboratories in Hamburg, Germany. The main technical characteristics of these dipoles are: 9-m length; 6.05 T magnetic field in the center, 6,540 A rated current; 4.6°K operating temperature. The dipoles are constructed and tested at room temperature in a 3,200 m^2 workshop divided into two areas. In the first area, which is kept at a steady temperature and humidity and subjected to strict cleanliness regulations, the collared dipoles are constructed and tested. Three winding lines ensure that more than one dipole is produced each day. 3 refs.

28835 **New documentation from the Los Alamos Accelerator Code Group.** Cooper, R.K. (Los Alamos National Laboratory, Los Alamos, (NM)); Menzel, M.T.; Stokes, H.K.; Warren, J.L. pp. 2030 of Proceedings of the 1987 IEEE particle accelerator conference: Accelerator engineering and technology. Lindstrom, E.R.; Taylor, L.S. IEEE Service Center, Piscataway, NJ (USA) (1987). (CONF-870302–: Particle accelerator conference, Washington, DC (USA), 16-19 Mar 1987).

Within the past two years, the Los Alamos Accelerator Code Group has produced four new documents for computer codes which are now available on request. These are: MAFIA User Guide; Reference Manual for the POISSON/SUPERFISH Group of Codes; User's Guide for the POISSON/SUPERFISH Group of Codes; and A compendium of Computer Codes Used in Particle Accelerator Design. They are discussed in this paper.

4302 Beam Dynamics, Field Calculations, and Ion Optics

Refer also to citation(s) 28612, 28796, 28797, 29400, 29401

28836 (CONF-890335–276) **Intense electron beam propagation across a magnetic field.** Zhang, X.; Striffler, C.D.; Yao, R.L.; Destler, W.W.; Reiser, M.P. Maryland Univ., College Park, MD (USA). [1989]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-85ER40216. From 1989 IEEE particle accelerator conference; Chicago, IL (USA); 20-23 Mar 1989. Order Number DE90009993. Available from NTIS, PC A02/MF A01; OSTI; INIS.

In this paper we consider the propagation of an intense electron-ion beam across an applied magnetic field. In the absence of the applied field, the beam system is in a Bennett equilibrium state that involves electrons with both large axial and thermal velocities and a cold stationary space-charge neutralizing ion species. Typical parameters under consideration are $V_0 \sim 1$ MV, $I \sim 5$ kA, $T_e \sim 100$ keV, and beam radii ~ 1 cm. We find that in the intense beam regime, the propagation is limited due to space-charge depression caused by the deflection of the electron beam by the transverse field. This critical field is of the order of the peak self-magnetic field of the electron beam which is substantially higher than the single particle cut-off field. 8 refs., 3 figs.

28837 (CONF-890335–277) **Measurements and simulation of controlled beamfront motion in the Laser Controlled Collective Accelerator.** Yao, R.L.; Destler, W.W.; Striffler, C.D.; Rodgers, J.; Scgalov, Z. Maryland Univ., College Park, MD (USA). [1989]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-85ER40216. From 1989 IEEE particle accelerator conference; Chicago, IL (USA); 20-23 Mar 1989. Order Number DE90009992. Available from NTIS, PC A02/MF A01; OSTI; INIS.

In the Laser Controlled Collective Accelerator, an intense electron beam is injected at a current above the vacuum space charge limit into an initially evacuated drift tube. A plasma channel, produced by time-sequenced, multiple laser beam ionization of a solid target on the drift tube wall, provides the necessary neutralization to allow for effective beam propagation. By controlling the rate of production of the plasma channel as a function of time down the drift tube, control of the electron beamfront can be achieved. Recent experimental measurements of controlled beamfront motion in this configuration are presented, along with results of ion acceleration experiments conducted using two different accelerating gradients. These results are compared with numerical simulations of the system in which both controlled beamfront motion and ion acceleration is observed consistent with both design expectations and experimental results. 5 refs., 6 figs.

28838 (DOE/ER/40216–7) **Accelerator research studies: Technical progress report, June 1, 1989–May 31, 1990.** Maryland Univ., College Park, MD (USA). [1990]. 132p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-85ER40216. Order Number DE90009983. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

This progress report for the Accelerator Research Studies program at the University of Maryland covers the second year (June 1, 1989 to May 31, 1990) of the current three-year contract period from June 1, 1988 to May 31, 1991, funded by the Department of Energy under Contract No. AC05-85ER40216. The research program is divided into three separate tasks, as follows: the study of Transport and Longitudinal Compression of Intense, High-Brightness Beams; the study of Collective Ion Acceleration by Intense Electron Beams and Pulse-Powered Plasma Focus; the study of Microwave Sources and Parameter Scaling for High-Frequency Linacs. This report consists of three sections in which the progress for each task is documented separately. An introduction and synopsis is presented at the beginning of the progress report for each task.

28839 **Principles of neutron reflection.** Felcher, G. P. (Argonne National Lab., IL (USA)). pp. 210 of Thin-film neutron optical devices: Mirrors, supermirrors, multilayer monochromators, polarizers, and beam guides. Majkrzak, C. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract W-31109-ENG-38. (CONF-8808212–: Thin-film neutron optical devices: mirrors, supermirrors, multilayer monochromators, polarizers, and beam guides, San Diego, CA (USA), 16-17 Aug 1988).

Neutron reflection is perhaps the most developed branch of slow neutrons optics, which in itself is a direct consequence of the undulatory nature of the neutron. After reviewing the basic types of interactions (nuclear and magnetic) between neutrons and matter, the formalism is introduced to calculate the reflectivity from a sample composed of stacked flat layers and, inversely, to calculate the stacking from reflectivity measurements. A survey of the applications of neutron reflection is given, both in technology and in fundamental research.

28840 Design of high-reflectivity supermirror structures. Hayter, J.B. (Oak Ridge National Lab., TN (USA). Solid State Div.); Mook, H.A. pp. 210 of Thin-film neutron optical devices: Mirrors, supermirrors, multilayer monochromators, polarizers, and beam guides. Majkrzak, C. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract AC05-84OR21400. (CONF-8808212–: Thin-film neutron optical devices: mirrors, supermirrors, multilayer monochromators, polarizers, and beam guides, San Diego, CA (USA), 16-17 Aug 1988).

The authors present a new method of designing supermirrors, based on considering the contribution of each bilayer to the extinction in a given stack of bilayers, and derive and solve the discrete equations governing the choice of layer thicknesses. In the limit of zero layer thickness, the usual continuum result is recovered. The design, which can produce essentially perfect reflectivity over the entire supermirror range, also provides an objective physical mechanism for trading reflectivity to gain angular range.

28841 Multilayer monochromators for the soft x-ray and extreme ultraviolet. Barbee, T.W., Jr. (Lawrence Livermore National Lab., Livermore, CA (USA)); Pianetta, P. pp. 304 of Synchrotron radiation in materials research. Clark, R; Gland, J.; Weaver, J.H. Materials Research Society, Pittsburgh, PA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8811224–: Synchrotron radiation in materials research, Boston, MA (USA), 28-30 Nov 1988).

Simple multilayer structures and multilayer diffraction gratings are now of sufficient quality to be used as optical elements in synchrotron radiation source instrumentation. In this paper results obtained with a multilayer two element monochromator are presented. Transmission measurements of the absorption cross-sections of elemental thin films in the energy range 50 to 2000 eV are presented and used to demonstrate the performance of the monochromator. Application of this monochromator in x-ray lithography research are described and the advantages of the broad bandpass of multilayer optics demonstrated. Uses of this monochromator on scattering studies of long period structures are discussed. The potential for the use of multilayer diffraction gratings in high resolution monochromator applications is considered.

28842 Radiation field from an extended planar-anode on HERMES III. Sanford, T.W.L. (Sandia National Labs., Albuquerque, NM (US)); Halbleib, J.A.; Poukey, J.W.; Beutler, D.E.; Carlson, G.A.; Baldwin, G.T.; Sheriden, T.; Mock, R.; Klinger, R.S.; Knott, D.P. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA)*, 36(6): 1931-1936 (Dec 1989). DOE Contract AC04-76DP00789. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

The bremsstrahlung field from an extended planar-anode diode with an annular cathode tip on the 16-TW HERMES III electron accelerator is measured and compared with predictions. Measurements confirm predictions and demonstrate that the diode provides a versatile large-area source of gamma radiation. Versatility is obtained by adjustment of the anode-cathode gap, which affects electron trajectories while simultaneously maintaining constant diode impedance. The adjustment permits the generation of average dose rates from about 1.2×10^{12} rad/s over 3100 cm^2 to about 5.6×10^{12} rad/s over 700 cm^2, without destruction of the bremsstrahlung target.

4303 Auxiliaries and Components

Refer also to citation(s) 28565, 28796, 28797, 28838, 28883, 28884, 28885, 29139, 29141, 29346, 29774, 29834, 29836

28843 (BNL–43944) **Synchrotron injectors based on high charge state ion sources.** Prelec, K. Brookhaven National Lab., Upton, NY (USA). 14 Feb 1990. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (AGS/AD–90-1). Order Number DE90009832. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The performance of any injector contemplated to replace the electrostatic tandem accelerators some time in the future should evidently match or surpass the characteristics of the tandems. It is a fortunate coincidence that the performance of the BNL tandem satisfies in most respects the requirements of the proposed collider, although originally tandems were not built with this application in mind. Requests for heavy ion beams with parameters suitable for injection into the rings of a heavy ion collider have appeared rather recently, at a stage when the high charge state ion sources, which in principle are capable of producing many ion species, have not yet reached such a level of performance. Therefore, consideration of such sources as part of a future injector replacing the tandem accelerators will have to rely on the extrapolation of results from existing models, developed for a different purpose. At the same time, present and future collider requirements for heavy ion beams should serve as a stimulus for the development of sources producing ions with adequate charge states and intensities. Injectors based on such sources may present a better alternative than the tandem accelerators because a higher charge-to-mass ratio of ions from the source results in a more efficient and less costly accelerator. In this report, two candidates for a high charge state, heavy ion source will be considered: an EBIS and an ECR. Other approaches, e.g. laser ion sources, are much further away in the development of a device to be used in a synchrotron injector. 25 refs., 7 figs., 4 tabs.

28844 (BNL–44474) **H^{minus} source and low energy transport for the BNL RFQ preinjector.** Alessi, J.G.; Brennan, J.M.; Kponou, A. Brookhaven National Lab., Upton, NY (USA). [1989]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-891055–15: 5. international symposium on the production and neutralization of negative ions and beams, Upton, NY (USA), 30 Oct - 3 nov 1989). Order Number DE90010135. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An RFQ has replaced the 750 keV Cockcroft-Walton as the H^- preinjector for the AGS. A magnetron surface-plasma source with a circular aperture is used to produce 65–100 mA of H^- at 35 keV with a discharge current of less than 20 A. The circular symmetry of the beam is maintained in the 2 m transport to the RFQ via the use of magnetic solenoids for focusing. Currents of up to 60 mA have been obtained out of the RFQ. 6 refs., 2 figs.

28845 (CEA-CONF–9975) **Operating experience with the 50 helix superconducting resonators of the Saclay heavy ion Linac.** Cauvin, B.; Girard, J.; Ramstein, G. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Physique Nucleaire. 1989. 12p. (CONF-8905141–: 5. international conference on electrostatic accelerators and associated boosters, Strasbourg (France), 24-27 May 1989). Order Number DE90773403. Available from NTIS (US Sales Only), PC A03/MF A01.

The Saclay Heavy Ion Superconducting Linac is now in full operation with all 50 resonators. The first half of the machine runs routinely since more than a year. We summarize in this paper our experience of the resonator behaviour on the accelerating line and give their present performances. Cooldown, multipactor barrier conditioning, and field raising procedures are also discussed.

28846 (CONF-890197–13) **A 30 MW, 10 GHz gyroklystron with linear collider application.** Lawson, W. (Maryland Univ., College Park, MD (USA)); Latham, P.E.; Calame, J.; Skopec, M.; Welsh, D.; Hogan, B.; Naiman, M.; Striffler, C.D.; Reiser, M.; Granatstein, V.L. Maryland Univ., College Park, MD (USA). 1989. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-85ER40216. From Workshop on advanced accelerator concepts; Lake Arrowhead, CA (USA); 9-13 Jan 1989. Order Number DE90009991. Available from NTIS, PC A03/MF A01; OSTI; INIS.

In this paper, the final preparations for bringing the University of Maryland's 10 GHz, 30 MW gyroklystron experiment on-line are discussed. We describe the initial operation of the modulator and the acceptance tests performed on the electron gun. We explain the enhanced circuit modelling and present a two-cavity design which predicts an efficiency of 33% and a gain of 27 dB. The realization of the design is also discussed. In addition, we briefly discuss the output waveguide and the diagnostics for beam and rf characterization. Finally, a four-cavity circuit design is presented with its predicted operating parameters that can achieve the necessary gain and efficiency required for accelerator application. 14 refs., 11 figs., 5 tabs.

28847 (FNAL-TM–1640) **Measurements of the Fermilab 200 MeV transfer line quadrupole magnets.** Kroc, T. Fermi National Accelerator Lab., Batavia, IL (USA). 22 Mar 1990. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE90010162. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report presents the results of measurements of two quadrupole magnets that are used in the 200 MeV transfer line. The measurements were performed to obtain data to evaluate the suitability of these magnets for use in a 400 MeV transfer line once the Linac Upgrade is complete. In order to provide a basis for comparison, data were obtained from Fermilab's Magnet Test Facility of measurements of magnets of similar size and strength that were built for the Loma Linda project. These Loma Linda magnets are possible replacements for the ones presently in the 200 MeV transfer line. The Fermilab Linac Upgrade includes the reconfiguration of the transfer line that runs from the linac to the booster in order to handle the higher beam energy. Nominally, the quadrupole strengths will need to be 1.5 times their current operating points. This report will use a value of 1.7 to allow a tuning range to account differences in geometry between the old and new lines. Another goal in the design of the new transfer line is to produce a non-steering line. A complaint about the current line is that steering results from any attempt to re-tune the line. 18 figs., 3 tabs.

28848 (FNAL-TM–1648) **16 Channel ECL repeater.** Graupman, D. Fermi National Accelerator Lab., Batavia, IL (USA). 7 Mar 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE90008179. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper describes the circuits of a 16 channel CL repeater. (LSP)

28849 (FNAL-TM–1650) **User's guide to ESME v. 7.1.** Stahl, S.; MacLachlan, J. Fermi National Accelerator Lab., Batavia, IL (USA). 26 Feb 1990. 55p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE90008182. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

ESME is a computer program to calculate the evolution of a distribution of particles in energy and azimuth as it is acted upon by the radiofrequency system of a proton synchrotron. It provides for the modeling of multiple rf systems, feedback control, spacecharge, and many of the effects of longitudinal coupling impedance. The capabilities of the program are described, and the requirements for input data are specified in sufficient detail to permit significant calculations by an uninitiated user. The program is currently at version 7.1 and extensively modified since the previous user documentation. Fundamental enhancements make version 6 data unusable, but nearly all facilities of the earlier version have been retained and input data is similar. Also described is a VAX-based code management convention which has been established with a view to maintaining functional equivalence in versions used on different computers. 13 refs.

28850 (GSI–88-20) **High current metal ion beam transport in the UNILAC injector at GSI.** Spaedtke, P. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.)); Emig, H.; Klabunde, J.; Rueck, D.M.; Wolf, B.H.; Brown, I.G. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany, F.R.). Oct 1988. 13p. Order Number DE90780365. Available from NTIS (US Sales Only), PC A03/MF A01.

Transport of high current beams of metal ions through the injector beam line of the heavy ion linear accelerator, UNILAC, has been demonstrated using the MEVVA high current metal ion source. Improved operation of the MEVVA source has been achieved in various ways, including shot-to-shot reproducibility of the beam pulse, beam noise, pulse shape, and absence of 'missing' pulses. The source was first tested on a high current test stand beam line, and then moved over to the regularly-used UNILAC injector terminal. Flat and reproducible titanium ion beam pulses were efficiently transported through the system from the ion source to the Wideroe pre-accelerator entrance. A beam current of 20 mA (pulse current) of titanium (all charge states, Q = 1, 2, 3) was accelerated to an energy of 280xQ keV through the single-gap accelerating structure, and a current of over 5 mA of Ti^{2+} was measured at the Wideroe entrance 13 m downstream. (orig.).

28851 (INS-T–486) **Reports from the technical engineers of the Institute for Nuclear Study.** Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Oct 1988. 86p. (In Japanese). Order Number DE90777883. Available from NTIS (US Sales Only), PC A05/MF A01.

The technical report meeting by the technical engineers of the Institute for Nuclear Study was held for the first time in the last year, and the report was issued. This meeting and report showed the importance of the activities of the engineers in wide range and of the technical support for the research organization of the university. In addition, those were effective for the mutual exchange in the Institute and further technical improvement. The technical report meeting in 1988 was held on June 2, and it was considered to continue the meeting regularly hereafter. This is the summary of the reports, and though the contents are a part of the activities of the engineers, those are really diverse. About 50 persons took part in the meeting. ECR action and nonresonant action of small microwave ion source, nonevaporable getter pump, development of hybrid type carbon films, development of the detector of focal plane position for β-ray spectroscopy, topaz IDC Rϕ track finder, simplified method of calculating neutron skyshine and present status of Institute for Nuclear Study network system and expansion plan were the themes of reports. (K.I.).

28852 (KEK–89-2, pp. 1-12) **Some applications of pressure distribution calculation.** Kanazawa, Ken-ichi (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-26 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

Pressure distribution calculations are used to evaluate the increase in pressure caused by synchrotron orbit radiation from the Trinstan accelerating ring. A study is also made to evaluate the local gas emission and leak from the accelerating and main rings. To determine the pressure distribution in a circular accelerator, an equation is generally derived by combining the mass conservation law and a law concerning the conductance for a given gas emission rate and evacuation rate of the vacuum pump, and it is solved under appropriate periodic boundary conditions. In the present study, the pressure distribution is calculated from a function based on the evacuation rate of the pump and the conductance of the conduit. The function, β (R) (where R is the 'resistance [s/l]' of the conduit, and used as the position coordinates), has the dimension of s/l, and its inverse represents the local evacuation rate. With this method, a reasonable value of about $1x10^{-5}$ molecules/photon is obtained for the gas emission rate at the arc portion. Reasonable results are also obtained for the change in average pressure and change in pressure distribution due to leak. It is demonstrated that the amount of leak can be easily determined by this method. (N.K.).

28853 (KEK–89-2, pp. 13-19) **Calculation for evacuation system comprising complex piping network.** Horikoshi, Gen-ichi (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Saito, Yoshio; Kakihara, Kazuhisa. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

An evacuation system for electron beam accelerator consists of an accelerator unit, evacuation manifold running parallel to it, and waveguide for microwave transmission, forming a complex network. The pressure distribution in such a system cannot be calculated through one-dimensional multiple connection. A method based on the Kirchhoff's theory for electric circuits has to be adopted for these calculations. The report outlines an 'extended' Kirchhoff's law and discusses major features of the method. First, a

vacuum pump and evacuation piping connected to it are discussed as a pipe unit constituting a network. The evacuation rate of the vaccum pump is regarded as the driving force, just as the electromotive force of a power source provides the driving force for a circuit network. A calculation method is derived for a network consisting of units with the same cross section and gas emission rate. Finally, a discussion is made of some issues requiring further investigations, including the conductance of a pipe with a limited length, known and unknown parameters in vacuum calculations, and Green functions for a piping network. (N.K.).

28854 (KEK–89-2, pp. 24-30) **Measurement and evaluation of pumping speed and gas discharge characteristics of titanium getter pump by conductance modulation method.** Terada, Keiko (Tokyo Univ. (Japan). Inst. of Industrial Science); Okano, Tatsuo; Tsuji, Hiroshi. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

The conductance modulation method is designed to determine the pumping speed from a known conductance. With the method, the intrinsic pumping speed Sp and net pumping speed S* can be determined in a wide range up to near the ultimate pressure. In the present study, the pumping speed and gas discharge rate of a titanium getter pump at 77K are analyzed, and the results are compared with measurements made at room temperature. The pressure in a vacuum chamber depends on the gas load and the pumping speed. The pressure varies from P_A to P_B as the conductance of the orifice is changed from C_A to C_B. The ultimate pressure also changes from P_{AO} to P_{BO}. The intrinsic and net pumping speeds can be calculated from P_A, P_B, P_{AO} and P_{BO}. The major feature of the conductance modulation method is that the intrinsic and net pumping speeds can be determined from a change in the conductance without knowing the sensitivity of the vacuum meter or the flow rate of gas entering the chamber from outside. With this feature, the method is very effective for measuring the balance between the gas discharge and pumping speed near the ultimate pressure. (N.K.).

28855 (KEK–89-2, pp. 49-55) **Heat cycle test of improved knife-edge type metallic sealing flange.** Obara, Kenjiro (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research EstablishmentJP); Nakamura, Kazuyuki; Murakami, Yoshio; Naganuma, Masamitsu; Kitamura, Kazunori; Uchida, Takaho; Kondo, Mitsunobu. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

High in reliability, the knife-edge type metallic sealing flange has been widely used in vacuum equipment, though it has some problems. To solve them, an improved flange (called IPD flange) is developed which is 1/2 to 1/3 in the number of bolts, about 3/5 in torque and about 7/10 in thickness as compared to conventional flanges. The present report focuses on a heat cycle test of the improved flange. The test covers two types of the improved flange with a diameter of 70mm and 152mm, which are referred to as IPD70 and IPD152, respectively. The maximum baking temperatures used were 500degC and 400degC. Both IPD70 and IPD152 showed a satisfactory sealing performance under high-humidity conditions at 400degC and 500degC. IPD70 was subjected to 60 heat cycles in the temperature range from 100degC to 400degC. Results show that the flange is satisfactory in sealing performance and integrity. At temperatures exceeding 300degC, the torque for IPD70 and IPD152 should be in the range of 80-100kg·cm and 100-125kg·cm, respectively, to ensure a high reliability for sealing. The improved flange is higher in performance than conventional flanges. (N.K.).

28856 (KEK–89-2, pp. 56-62) **Present status of vacuum system for Tristan.** Momose, Takashi (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Kanazawa, Ken-ichi; Suetsugu, Yusuke; Hisamatsu, Hiromi; Shimamoto, Miyuki; Nakagawa, Mitsuru; Sato, Masayuki; Ishimaru, Hajime. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

The Tristan's electron-positron collision ring at High-Energy Physics Research Institute has been operating for two and a half years since October 1986 to March this year or 1989. Various efforts have been carried out for enhancing its performance, including the improvement in the distributed ion pumps (March-April 1987), extension of the radio-frequency wave cavity (August-September 1988) and installation of a superconduction cavity. Accordingly, the beam energy was increased from the initial 23GeV to 30.4GeV in the fall of 1988, and the beam current reached a maximum of 14mA in 1988. The luminosity also increased to 1.3×10^{31} in 1988, and the time-integrated beam current reached 27A·h at the end of March 1989. For the vacuum system for Tristan, troubles associated with the initial faults have been eliminated. Regular inspection and maintenance has resulted in a decreased number of troubles that could cause shutdown, though checking should be performed continuously for radiation damage. The average beam life has exceeded five years, and the pressure increase is currently of the order of 10^{-8} Pa/mA. Further improvements should be made in the future to increase the beam life. (N.K.).

28857 (KEK–89-2, pp. 128-134) **TiN coating of alumina microwave window.** Matsuda, Namio (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Saito, Yoshio; Anami; Shozo; Kinbara, San; Horikoshi, Gen-ichi. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

For the liniac at the High-Energy Physics Research Institute, a high-purity alumina window (disc with 99% purity, 92mm diameter, 3.5mm thickness) has been used to maintain the vacuum during the replacement of the klystron in the wave guide used for the transmission of large-power microwave (maximum 30MW, 2856MHz, 3.5μSx50pps). The alumina window is coated with titanium nitride to a thickness of about 5nm and the klystron is conditioned carefully to prevent the window from being destroyed during large-power operation. The coating with titanium nitride is performed by direct-current sputtering. Typical sputtering conditions for titanium nitride film deposition onto alumina ceramic disks are shown, and the dependence of the deposition rate on the total pressure is examined. It is found that the deposition rate depends largely on the pressure in the pressure range examined. The equipment used for measuring the surface resistance is illustrated, and the relations between the specific resistance and thickness of the titanium nitride film are studied. AES analysis is carried out to determine the N/Ti ratio. Measured electron-energy-loss spectra are also shown. (N.K.).

28858 (KEK–89-2, pp. 139-149) **Double vacuum vessel for KEK klystron.** Narishima, Katsunari (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Sato, Yoshihiro; Saito, Yoshio; Matsuda, Namio; Mizuno, Hajime; Horikoshi, Gen-ichi. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

High-Energy Physics Research Institute (KEK) has been engaged in the planning of a large-scale hadron program and a linear

collider program as major projects to follow the Trinstan Program. One of the key elements to the successful implementation to these programs is a microwave source several times as large as those currently available. The candidate technique most likely at present is the use of a large-scale klystron. Investigations so far indicated that a detailed study should be made to develop a process for heat treatment of a klystron, which is the most important process in producing a klystron. As key equipment for this, it is planned to develop a 'double vacuum vessel' to be used for heating/evacuation, which is performed at the final stage of the treatment of a klystron. The equipment consists of a vacuum vessel containing an assembled large-scale klystron. The pressure inside and outside the klystron is reduced to below 10^{-8} Pa and 10^{-4} Pa, respectively, before heating it at temperatures of 150-700degC. Specifications for various components including the vessel, heater-controlling power source, pumping system, etc. are described. (N.K.).

28859 (KEK–89-2, pp. 217-221) **Reduction-type current-limiting ion pump power source.** Hisamatsu, Hiromi (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Momose, Takashi; Ishimaru, Hajime. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

The leakage-transformer type ion pump power source has been widely used because of the protection against short-circuit current. The start-up of an ion pump by this type of power source, however, requires frequent turning on and off operations in order to prevent the overheat of the ion pump. At the High-Energy Physics Research Institute, a small power source for dust collector has been used to maintain the vacuum after the start-up with a leakage-transformer type power source. The one for dust collector is a reduction-type current-limiting power source in which both the current and voltage becomes zero when a overload occurs. At the Institute, an ion pump power source that combines the reduction-type current limiting mechanism and DC-DC converter type mechanism has been installed for about 1,100 ion pumps used for the accumulating ring and main ring of Tristan. The ion pump power source has the following features: (1) it requires only one turning-on operation, and is suitable for the computer control of a distribution-type pumping system, (2) it is smaller in size and weight (about 1/5 compared to conventional equipment), and (3) it consists of separate modules. (N.K.).

28860 (KEK–89-2, pp. 222-226) **Electrostatic vacuum dust collector.** Saeki, Hiroshi (Matsushita Electric Industrial Co. Ltd., Kadoma, Osaka (Japan)); Ikeda, Junji; Takatsu, Isao; Ishimaru, Hajime. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

A clean environment is a key facility required for the production of high-density integrated circuits. In fact, dust could have a serious effect on the yield of semiconductor production. Conventional equipment is ineffective for dust released within the vacuum chamber. Here, new equipment is developed which uses electron beam and electrostatic force to collect dust in a vacuum. This electrostatic dust collector incorporates tape to collect dust, the tape being in contact with an electrode. The electrode consists of a dielectric layer and a conductive layer, and is charged positive by an external high-voltage, direct-current power source. Some basic tests are performed to demonstrate its performance. Conducting dust can be collected by electrostatic force alone. Semiconducting or insulating dust is charged negative by electron beam and then collected by positive electrostatic force. The use of tape makes it possible to collect dust in large amounts as compared to the conventional plate-type equipment. Test results show that the equipment can perform continuous dust collection. More than 90 percent of the total dust used in the test is found to be collected. (N.K.).

28861 (NAC-AR–86-01, pp. 4-19) **The 200 MeV cyclotron facility: The injector cyclotrons.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Protons at various energies up to 8 MeV have been accelerated and extracted from SPC1. An extraction efficiency of ≈100% was obtained at maximum energy. Internal beams of deuterons and α-particles have also been accelerated. In general, the cyclotron performed satisfactorily. Two major breakdowns occurred at maximum rf-power due to overheating, and modifications were made to prevent this from happening again. The diagnostic system of SPC1 was extended by designing and building a non-intercepting beam profile monitor. It has proved to be of big help in setting up SPC1 for beam production. Most of the design parameters of SPC2 have been fixed and design calculations were made for various inflectors. Design of the central region is still in progress. Two external ion sources and components for the main magnet have been ordered. 12 figs., 1 tab., 3 refs.

28862 (NAC-AR–86-01, pp. 50-55) **The separated-sector cyclotron: Injection.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

During the past year the central region of the SSC was finally installed with all its services. The magnetic inflection channel (MIC) was assembled and mounted into its driving mechanism. Magnetic field measurements were carried out to determine the effect of the MIC on the sector magnet field. All the individual items and components were tested under operating conditions and the first beam was successfully injected into the SSC. From the first operating experiences one can conclude that the injection system functions as anticipated and that the commissioning phase has thus come to an end. 5 figs.

28863 (NAC-AR–86-01, pp. 73-87) **The separated-sector cyclotron: Beam diagnostics.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Good progress has been made during the past year with the implementation of a beam diagnostic system, many components of which were used during the first beam acceleration trials in the SSC. The diagnostic components in the central region have been installed and linked to their respective electronic systems. The multi-head probes and the beam stop have been manufactured, installed and tested under operating conditions. An injection collimator has been designed and installed. The axial graphite collimators were mounted inside the north valley vacuum chamber. An extraction collimator was designed to dissipate up to 10 kW of beam power, manufactured and installed. All the collimators in front of the various extraction components have been mounted. The scanner on the first septum magnet was delivered, together with its electronic system; both have been installed and are operational. The detail design of two identical extraction probes (harps) is nearing completion. The main beam current measurement system has been manufactured and implemented, while the development of a current measurement system for the harps of the extraction probes is underway. Excellent performance was obtained in tests with the beam phase measurement system. The closed-circuit TV system is operational. 15 figs.

28864 (NAC-AR–86-01, pp. 88-94) **The separated-sector cyclotron: Orbit calculations.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The orbit code was modified in order to be able to calculate injection orbits, to study beam depolarization in cyclotron magnets and to calculate the effect of a proposed pulse selector on accelerated beams in the separated-sector cyclotron. Improvements were made to programs which predict current settings for the main coils and trim-coils of the four sector magnets. 3 figs., 3 refs.

28865 (NAC-AR–86-01, pp. 20-30) **The separated-sector cyclotron: Sector magnets.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The four 350-ton sector magnets have been put into service successfully in the past year, and protons were accelerated with the seperated-sector cyclotron (SSC) for the first time during October 1985 to 66 MeV, and to 200 MeV in May 1986. In both cases the predicted main excitation current had only to be reduced slightly to obtain the isochronous magnetic field required in the SSC for full transmission of the injected beam up to the extraction radius. All magnet components as well as the computer control of the 41 power supplies perform very well under operating conditions. By analysing the 40 million field data accumulated previously, the excitation characteristics of the magnets have been determined, and a data base has been established which now allows us to evaluate the magnetic field in the SSC to within a few parts in 10^4 for orbit calculations and more accurate predictions of current settings. A compact magnetic field measuring device with temperature control has been developed for general applications at the NAC. Existing field computation programs and equipment for magnetic field measurement have been maintained, and a calibration service for Hall plates was provided. 10 figs., 3 refs.

28866 (NAC-AR–86-01, pp. 31-39) **The separated-sector cyclotron: Radio-frequency system.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The radio-frequency system of the SSC provides the voltages required for the acceleration of the beam particles by means of two large resonators. The east resonator was tested on its own in the SSC vault during August 1985, while the west resonator was installed at the end of August. Both were evacuated as part of the SSC ring at the end of September and operated with 90 kV at 16,4 MHz to accelerate the first internal beam in the SSC to 66 MeV on 9 October. During October and November the resonators were tested at 12,5 15,0 16,4 22,5 and 26 MHz and the influence of the magnetic field on multipacting and conditioning was investigated. Operation up to the maximum designed peak voltage of 250 kV was achieved after some initial problems were overcome. At maximum voltage a power level of 100 kW is reached in each resonator. Between December and February the bellows of the main capacitors were replaced by an improved version and the first extraction magnet (SPM1) was installed in the west resonator. During April the resonators were conditioned for the full range of magnetic field settings, and 240 kV at 26 MHz was used to accelerate an internal beam to 200 MeV. During the operation of te SSC the control system, which also provides phase and amplitude stabilization, and the power amplifiers have performed well. 3 figs., 1 tab., 1 ref.

28867 (NAC-AR–86-01, pp. 40-49) **The separated-sector cyclotron: Vacuum system.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The vacuum system of the SSC has been commissioned during the past year, and the cyclotron was evacuated successfully for the first time in September 1985. The operating pressure ($\approx 10^{-4}$ Pa) required for the first SSC beam has been reached with encouraging ease, although only a preliminary pumping system was installed at that stage. The good vacuum properties of the SSC were confirmed later, when all available pumps were installed and the system was fully operational. These properties can be attributed to a nearly leak-free system, the low outgassing rates apparently achieved for all surfaces which are exposed to the vacuum, and to the excellent performance of the pneumatic expansion seals between the eight separate chambers forming the vacuum envelope. The most serious set-back was experienced when it was established that the two large 6,5 m^3/s turbo-molecular pumps cannot be used on the SSC as originally planned, owing to excessive vibrations which damage delicate equipment installed in the chambers. Fortunately these pumps are not necessary at present during normal operation, and they will be replaced with 2 m^3/s turbo-molecular pumps as soon as possible. Only a few leaks have had to be repaired on the SSC up to now, and an operating pressure in the 10^{-5} Pa range can be achieved regularly. After initial interference arising from a high-voltage power supply for the electrostatic extraction channel, the vacuum control system now gives trouble-free service. 7 figs.

28868 (NAC-AR–86-01, pp. 100-115) **The beam transport system: Magnets.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The transfer beamline between SPC1 and the SSC is operational, and has been used successfully to transport proton beams of up to 8 MeV into the SSC. An additional 2,3 degrees steering magnet has been built and inserted at the end of this line to compensate for stray return flux between the SSC sector magnets. Measurements of effective length, harmonic content and magnetic centre have been completed on the 60 quadrupole magnets of the 'high-energy' beamlines. Field mapping has also been completed for the entrance and exit regions of the large 90 degrees dipole magnets for the double monochromator serving the experimental target areas, as well as for the 90 degrees dipole for the vertical isotope production beamline. The 'high-energy' beamlines leading to the isotope production and neutron therapy vaults respectively, have been completed, as has the double-monochromator beamline up to the 60 degrees switching magnet, which is presently being installed. Tenders for many of the components for a K=600 magnetic spectrometer have been awarded. 13 figs., 1 tab., 5 refs.

28869 (NAC-AR–86-01, pp. 116-123) **The beam transport system: Beam diagnostics for beamlines.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The first proton beams have been transported along the transfer beamline and the diagnostic components have thus been used and tested under real operating conditions. The various electronic systems have been linked to the control system and the equipment can now be operated from the control console. The performance of the diagnostic system for the transfer beamline is satisfactory. The beam diagnostic components for the high-energy beamlines up to the isotope production and neutron therapy vaults and the first experimental target rooms have been installed. The high-energy slits have been delivered. The scanner and harp electronics have been installed and linked to their respective components in the beamlines. The pneumatic acuator control electronics has been manufactured, installed and is operational; provision has been made for special control features of the equipment in the therapy beamline. The high-voltage bias supply for the Faraday cups has been implemented. The installation of the beam current measurement system is nearing completion although part of it is already operational. A coaxial relay multiplexer for the capacitive phase probe signals has been manufactured and installed. The diagnostic equipment for the beamlines to isotope production and neutron therapy is thus ready for operation. 4 figs.

28870 (NAC-AR–86-01, pp. 124-128) **The beam transport system: Beamline vacuum system.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The vacuum system for the transfer beamline gave reliable service during the past year. Installation of the vacuum system for the main parts of the high-energy beamlines has been completed except for a small section in the isotope production area and the two therapy lines which are not required at present. All the pumps, valves and gauges from the SSC to the experimental area have been installed. The control systems for the high-energy beamlines have been manufactured, installed and partly commissioned. 4 figs.

28871 (NAC-AR–86-01, pp. 129-130) **The beam transport system: Buncher.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The buncher is required to reduce the beam pulse lenght to a small enough value at injection into the SSC to allow the acceleration of beam currents up to 100 microamps without serious beam loss. It will be situated in the beamline at a point aproximately halfway between SPC1 and the SSC, where the beam is focused to a horizontal and vertical waist.

28872 (NAC-AR–86-01, pp. 131) **The beam transport system: Pulse selector.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

A pulse selector is necessary for some experiments to enable a longer time between beam pulses to be obtained. This is achieved by deflecting some of the pulses so that they can be intercepted by a collimator. Two deflecting plates will be installed at the point of entry of the injection beamline into the injection valley chamber. The collimator will be situated near the central region.

28873 (NAC-AR–86-01, pp. 169-172) **The Pretoria cyclotron facility: Cyclotron operation and development.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

After suspecting misaligned pole plates as the underlying cause of the vertical dispersion and displacement of the extracted beam, it was decided to undertake a major service of the cyclotron during the first quarter of 1986. The main vacuum chamber was removed, the O-rings replaced and the magnetic field measured. Other improvements included the installation of a new electromechanical drive system for the capacitor plates, modifications to the vacuum valve of the isotope production chamber, the installation of a new chiller for the deflector and the upgrading of the main magnet stabilizer with a new shunt. During this period two programmable controllers were commissioned to interlock the water flow circuitry with the existing interlock subsystems, a new power supply was installed for the ion source filament and new vacuum sensors located on the therapy beamline. The frequent interruptions and breakdowns during the past year have highligted once more the need for support from the Faure personnel and two major improvements are to be jointly undertaken; a theoretical study of particle orbits at the central region of the cyclotron with the aim of improving orbital separation and the design of an electromechanical drive system for the ion source. 1 tab.

28874 (NAC-AR–86-01, pp. 148-150) **The research group: Experimental nuclear physics.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The analysis of the measurements on the elastic scattering of α-particles on ^{28}Si has been completed. Development of experimental facilities as well as data-handling hardware and software for the experimental research programme at the SSC progressed as anticipated, except that the beam swinger system has been delayed. Contracts have also recently been concluded for the manufacture of most of the major components of a K=600 magnetic spectrometer. 1 fig., 2 refs.

28875 (NAC-AR–86-01, pp. 151-153) **The research group: Standards of radioactivity.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

A ^{57}Co sample was standardized and a sample was sent to the International Reference System (SIR) of the BIPM for a comparative measurement. Comparison with the SIR average indicates that the quoted activity is higher, but a proper assessment is difficult. The NAC also participated in the international comparison of ^{109}Cd activity measurements organised by the BIPM. The activity was measured using two methods based on liquid scintillation coincidence counting. The results of the intercomparison are still awaited. The new 15-fold coincidence counting system came into operation and has been proven successful. An accurate ionization chamber has also been purchased and tested. 1 fig., 2 refs.

28876 (NAC-AR–86-01, pp. 154-162) **The research group: Radioisotope production.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The development of a microcomputer-based remote control and monitoring system for target handling and target irradiation procedures is well advanced. The electric rail target transport system was installed, while the design of a remotely-controlled multiple target facility for the first beamline has been completed and some of its components are already being manufactured. Systems for water cooling of various combinations of targets of different configurations, as well as for helium-gas cooling of beam foil windows have been proposed. Instrumentation racks and general service lines were installed at the hot cells and a shielded facility for the transfer of radioactivity between hot cells has been designed. A counting room for the measurement of radio-activity has been established and a SPECT γ-camera was installed in the Nuclear Medicine Block. Other equipment acquired includes an atomic absorption spectrophotometer and a high-performance liquid chromotograph. A collection system for the recovery of ^{123}I from irradiated NaI targets has been prepared, while improved methods for the preparation and quality control of iodine-labelled Hippuran and MIBG have been developed. 4 figs., 6 refs.

28877 (NAC-AR–86-01, pp. 208-210) **Nuclear analytical chemistry: Improvement of facilities.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

A transportable target holder has been constructed for the use of samples that are reactive to oxygen and/or moisture. Targets mounted under an inert atmosphere can be inserted at the irradiation site without exposure to air. Further imporvements have been and are being made at the MICRODOT-2 site to enhance reproducibility in positioning detectors, lead shielding and large samples. 1 fig.

28878 (NAC-AR–86-01, pp. 251) **Data acquisition and processing.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Short note.- DATA ACQUISITION/nac cyclotron; DATA ACQUISITION/van de graaff accelerators; DATA PROCESSING/nac cyclotron; DATA PROCESSING/van de graaff accelerators; COMPUTERS; PROGRESS REPORT

28879 (ORNL/FTR–3577) **[Power converters for particle accelerators]: Foreign trip report, March 24–31, 1990.** Mosko, S.W. Oak Ridge National Lab., TN (USA). 16 Apr 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009853. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended the CERN Accelerator School session on Power Converters for Particle Accelerators in Montreux, Switzerland, with about 75 other electrical engineers representing about 40 research laboratories from around the world. Most of the 20 lecturers were CERN staff members, while a few represented other labs and commercial organizations. The program covered topologies, characteristics, design techniques, and operating experiences for power converters in particle accelerator applications. Switch-mode power supply configurations were especially favored, and new technologies for energy storage were presented. A supplemental seminar on the sodium-sulfur energy storage system for electric vehicles was included. A field trip to CERN was included, with special attention to power converter equipment associated with the LEP accelerator.

28880 Transverse impedances of cavities and collimators. Kheifets, S.A. (Stanford Linear Accelerator Center, Stanford University, Stanford, CA (US)); Bane, K.L.F.; Bizek, H. pp. 2030 of Proceedings of the 1987 IEEE particle accelerator conference: Accelerator engineering and technology. Lindstrom, E.R.; Taylor, L.S. IEEE Service Center, Piscataway, NJ (USA) (1987). DOE Contract AC03-76SF00515. (CONF-870302–: Particle accelerator conference, Washington, DC (USA), 16-19 Mar 1987).

When an ultra-relativistic charge moves past a discontinuity in an accelerator vacuum chamber, electromagnetic fields are excited. A test charge following behind the exciting charge will, in general, experience a longitudinal kick (affecting its energy) and a transverse kick from these fields. The interaction can be characterized by the wakefield or the impedance of the structure. Either of these functions are useful for studying the current dependent behavior of a bunch of particles in an accelerator. It has long been possible to compute the longitudinal and transverse impedances of the periodic disk-loaded structure, as well as the impedances of cylindrically symmetric cavities with arbitrary shape, up to the tube cut-off frequency. The authors discuss the computation of the longitudinal impedance of simple cavities and collimators, and of arbitrarily shaped cylindrically symmetric structures, including frequencies above cut-off.

28881 A high level, low frequency RF system for the acceleration of light ions in the AGS. Sanders, R. (Brookhaven Nat. Lab., Upton, NY (US)); Barton, D.; Frey, W.; Montemurro, P.; Otis, A.; Plotkin, M.; Pritsker, M.; Soukas, A.; Tuozzolo, J.; Zaltsman, A. pp. 2030 of Proceedings of the 1987 IEEE particle accelerator conference: Accelerator engineering and technology. Lindstrom, E.R.; Taylor, L.S. IEEE Service Center, Piscataway, NJ (USA) (1987). (CONF-870302–: Particle accelerator conference, Washington, DC (USA), 16-19 Mar 1987).

A high level, low frequency RF system for accelerating light ions is described. This system accelerates ions from typically 7 to 8 MeV/nucleon to 200 MeV/nucleon. It operates at the 12th harmonic of the AGS rotation frequency, in a nominal range of 0.5 to 2.5 MHz. It preaccelerates the beam so that a synchronous bucket-to-bucket transfer can be made to the present AGS proton RF system for further acceleration up to energies of about 14 GeV/nucleon, covering the frequency range of 2.5 to 4.5 MHz. An existing preconversion AGS two-gap cavity was rebuilt to cover the low frequency range and to accommodate gap voltages as high as 8.5 kV (magnetic field rise rate of 1.2 kG/sec). The cavity is driven by a push-pull tetrode power amplifier and driver chain capable of delivering over 100 kW.

4304 Storage Rings

Refer also to citation(s) 28807, 28821, 28830, 28831, 28832, 28833, 28834, 28856, 29385, 29386, 29387, 29392, 29399, 29402, 29403, 29410, 29411

28882 (FNAL-TM–1649) **New Main Ring control system.** Seino, K.; Anderson, L.; Ducar, R.; Franck, A.; Gomilar, J.; Hendricks, B.; Smedinghoff, J. Fermi National Accelerator Lab., Batavia, IL (USA). Mar 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-891094–17: International conference on accelerator and large experimental physics control systems, Vancouver (Canada), 30 Oct - 3 nov 1989). Order Number DE90008180. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Fermilab Main Ring control system has been operational for over sixteen years. Aging and obsolescence of the equipment make the maintenance difficult. Since the advent of the Tevatron, considerable upgrades have been made to the controls of all the Fermilab accelerators except the Main Ring. Modernization of the equipment and standardization of the hardware and software have thus become inevitable. The Tevatron CAMAC serial system has been chosen as a basic foundation in order to make the Main Ring control system compatible with the rest of the accelerator complex. New hardware pieces including intelligent CAMAC modules have been designed to satisfy unique requirements. Fiber optic cable and repeaters have been installed in order to accommodate new channel requirements onto the already saturated communication medium system. 8 refs., 2 figs.

28883 (KEK–89-2, pp. 63-67) **Vaccum system for storage ring in Taiwan.** Liu, Yuan-Zhong (National Tsing-Hua Univ., Hsinchu, Taiwan (China)); Chen, Jun-Rong; Xiong, G.; Wang, Duon-Zheng; Chen, Yin-Shang; Ceng, Hu-Xing; Xu, Xian-Neng; Peng, Xian-Yao. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

The construction of an electron storage ring with an energy accumulation capacity of 1.3GeV has been under way at the Synchrotron Radiation Research Center (SRRC) in Taiwan. The facility comprises a linear accelerator of 50MeV and a synchrotron of 1.3GeV. The storage ring, 120m in length, comprises TBA-type lattices and 18 deflecting magnets to deflect the beam by 20deg. The vacuum system for the 1.3GeV electron storage ring at SRRC was designed on the basis of calculations of the pressure distribution. An aluminum alloy was adopted as material for the vacuum chambers, allowing its design and production to be performed by a simple process. The chamber at the linear portion was produced by a special extrusion process while the chamber for the deflector was produced by EL processing and TIG welding. The surface properties were analyzed and the gas release rate was measured. Results have shown that the chambers can have fairly good vacuum characteristics. Pumping tests were also carried out using an ion pump and a getter pump. A vacuum of 10^{-10}-10^{-11} Torr was achieved rapidly in each of the chamber. Shields are provided to minimize the RF inpedance at various parts of the ring. (N.K.).

28884 (KEK–89-2, pp. 74-83) **Vaccum system for 8GeV storage ring.** Sakamoto, Hiroyuki (Institute of Physical and Chemical Research, Wako, Saitama (Japan)); Yokouchi, Shigeru; Morimoto, Yoshihide; Lee, Young-Pak; Oikawa, Yoshifumi; Be, Suck-Hee. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

The report describes major features of the accumulation ring designed for the large-scale synchrotron orbit radiation facilities which are being designed by the Joint Study Team for Synchrotron Orbit Radiation established under the Institute of Physical and Chemical Research and the Japan Atomic Energy Research Institute. The vacuum in the accumulation ring should be InTorr or below in the electron-accumulated state to ensure a beam lifetime of about 20 hours. To achieve this vacuum, an Al alloy (A6063T6) extruded in an $Ar+0_2$ atmosphere is adopted as material for the vacuum chambers (straight chamber, bending chamber). Non-evaporation type getter (NEG) pumps and distributed ion pumps (DIP) are provided for the straight and bending chambers, respectively. Three types of pumps (centralized NEG pump, sputter ion pump, titanium sublimation pump) are provided for the crotch absorbers, which are to be directly irradiated with synchrotron radiations. The report briefly outlines the beam lifetime in the accumulation ring, some features of the vaccum chambers, thermal output and degassing rate associated with synchrotron radiation, and characteristics of the various pumps. (N.K.).

28885 (KEK–89-2, pp. 114-127) **Development of electrostatic separator for Tristan main ring.** Suetsugu, Yusuke (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Shintake, Tsumoru; Mori, Kenji; Sato, Masayuki; Higo, Nobuyasu. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

For the Tristan main ring, 16 electrostatic separators are developed and installed along the beam line. Their maximum service voltage is 240kV. Electromagnetic wave power left by the beam in the chamber (parasitic mode loss) is absorbed efficiently by a parastic mode damper after being taken out of the chamber through bushings. This eliminates the necessity for direct cooling of the electrodes and permits a simple structure. Positive electric contact between the parts is assured to prevent microscopic spark

discharge from being induced between imperfect-contact parts by strong pulsed wall current produced by bunch beam. An adequate study has been made for the processing of the surface of the chambers and electrodes in order to minimize the spark rate. Each of the bushings and ceramic supports is conditioned to 150kV. The separators are assembled in a clean room to eliminate dust and cuttings. The separators installed along the beam line can be maintained stably under a voltage of 240kV for two days or more without spark discharge. The leak current was below 7μA. During the accumulation and acceleration of 9mA beam, the separators can operate stably without a beam loss, demonstrating their practical performance. (N.K.).

44 INSTRUMENTATION

Refer also to citation(s) 27629

28886 (CGA–CE02953, pp. 331-334) **Electronic volume intergrators at Union Gas.** Laframboise, C.D. (Union Gas Ltd., Chatham, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

Union Gas has undertaken extensive testing of Electronic Volume Integrators (EVIs) recorders over the past two years with the intention of replacing the existing chart recorders for gas metering. This involved controlled atmosphere evaluation at the Ontario Research Foundation(O.R.F.) in Mississauga, field evaluation at selected customer locations and lab evaluation of transducer drift. The latest equipment from several manufacturers was tested. Over the course of testing, manufacturers were made aware of any problems encountered with their equipment such that representative results would fail to be generated. This paper is centered on the methodology of testing at O.R.F., field and calibration experience, and equipment features considered advantageous in satisfying Union's Measurement Improvement Plan. Prior to testing; all EVIs were calibrated against accepted temperature and pressure standards. Calibration was performed according to manufacturer's guidelines. Each EVI was tested under specific imputs of temperature and pressure. EVIs were installed in the field in conjunction with volume pressure temperature chart recorders on customer locations experiencing continuous year round use. Field checks were made monthly.

28887 (STEV-FGT–90-1) **Evaluation of an infrared N_2O analyzer.** Hulgaard, T. (Technical Univ. of Denmark, Lyngby (Denmark). Dept. of Chemical Engineering); Dam-Johansen, K.; Karlsson, M.; Leckner, B. Statens Energiverk, Stockholm (Sweden). Oct 1989. 26p. Project STEV-276-201. (CONF-8910386–1: 1. topic oriented technical meeting, Amsterdam (Netherlands), 11-17 Oct 1989). Order Number DE90770869. Available from NTIS (US Sales Only), PC A03/MF A01.

CHEC Article No. 8904.

A commercially available continuous infrared (IR) analyzer for analysis of N_2O in combustion flue gases has been evaluated with respect to accuracy, linearity, and possibly interfering species, using pure mixtures of N_2O, N_2, and the interfering species investigated one by one. The interference tests are made for: SO_2, H_2O, NO, NO_2, CO, CO_2, O_2 and CH_4. The IR-instrument is compared with gaschromatography with respect to accuracy and applicability. The linearity of the IR-analyzer is good. SO_2, H_2O, and CH_4 are found to be the major interfering components. The interference from H_2O can be eliminated by condensation of water vapour at a constant temperature prior to analysis. The interference from SO_2 depends on the concentrations of SO_2 and N_2O. It can be corrected for numerically or eliminated by removing SO_2 before analysis. Furthermore an unknown interfering component seems to be formed when NO passes the refrigerator containing an acid condensate. The absolute accuracy of the instrument during flue gas analysis is estimated roughly as ± ppm, provided H_2O condensation and only numerical correction for other interferences are performed. The detection of change, however, is much more accurate. The IR-analyzer is mainly applicable for analysis above 20 ppm N_2O or where interfering species are absent. Fluidized bed combustion, detection of change following NO_x abatement strategies at e.g. pulverized coal combustion, and laboratory experiments are apparent fields of application. The GC analysis is non-continuous, more time consuming, and suffers from the risk of N_2O formation in sample containers. On the other hand, GC-analysis is accurate even at low concentrations, and does not suffer from interference from common flue gas components. (16 figs., 2 tabs.).

4401 Radiation Instrumentation

Refer also to citation(s) 27772, 28789, 28810, 28812, 28828, 28841, 28851, 28875, 28876, 28877, 28923, 28934, 29180, 29356, 29392, 29397, 29398, 29517, 29668, 29718, 29719, 29720, 29721, 29722, 29723, 29725, 29727, 29749, 29753, 29759, 29760, 29761, 29762, 29775, 29776

28888 (CEA-CONF–9970) **New spectrofluorometer with pulsed intensified photodiodes array for direct trace determination of actinides and lanthanides in solutions.** Decambox, P.; Kirsch, B.; Mauchien, P.; Moulin, C. CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Chimie Appliquee et d'Etudes Analytiques. 1989. 6p. (CONF-890331–: 40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy, Atlanta, GA (USA), 6-10 Mar 1989). Order Number DE90773410. Available from NTIS (US Sales Only), PC A02/MF A01.

Actinides and lanthanides in solution at very low level are determined by Time-Resolved Laser-Induced Spectrofluorometry (TRLIS) with pulsed intensified photodiodes array detection. Temporal resolution allows discrimination against short lifetime fluorescence and measurement of fluorescence lifetime in various matrices. The use of laser source leads to excitation selectivity and high sensitivity. Multichannel detection allows to cover the entire wavelength range of interest which leads to emission selectivity and rapidity. These different advantages are present in the newly commercialized spectrofluorometer FLUO 2001 together with specially analytical adapted software. The apparatus and performances obtained for several actinides and lanthanides are presented.

28889 (CONF-891119–119) **Boron phosphide on silicon for radiation detectors.** Lund, J.C. (Radiation Monitoring Devices, Inc., Watertown, MA (USA)); Olschner, F.; Shah, K.S.; Ahmed, F. Radiation Monitoring Devices, Inc., Watertown, MA (USA); Devcom, Inc., Framingham, MA (USA). [1989]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC01-89ER80818. From Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989. Order Number DE90009562. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We report on radiation detectors fabricated from boron phosphide (BP) layers. These devices were fabricated by growing 1 to 10 μm thick layers of BP by chemical vapor deposition (CVD) on (100) oriented n-type silicon substrates. Ohmic contacts were applied to the Si (Au–Sb). Schottky barrier contacts (also Au–Sb) were applied to the BP layer. The devices were tested as radiation detectors and were found to be capable of detecting individual 5.5 MeV alpha particles. With some improvements we hope to fabricate neutron detectors from these devices, making use of the very high cross-section of boron for thermal neutrons. 10 refs., 2 figs.

28890 (DL/SCI/TM–62E) **On the use of single large-area photodiodes in scintillation counters: A review of available literature.** Morrell, C. Daresbury Lab. (UK). Dec 1989. 8p. Order Number DE90625163. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The compilation of this review was originally intended to assess the possibility of using photodiode-based scintillation counters in fluorescence EXAFS (or FLEXAFS) systems as a low-cost alternative to photomultiplier-based counters. The X-ray energies encountered in FLEXAFS experiments range from a few keV to a few tens of keV, and detectors are required to have some energy resolution and/or high count-rate capability in order to optimize the

quality of data collected. The results presented in the reviewed literature imply strongly that photodiodes do not compete successfully with photomultipliers in scintillation counting systems for X-ray energies below the order of 100keV, at least at the present stage of photodiode technology. Nevertheless it is likely that there are other applications requiring X-ray detectors for which a photodiode-based scintillation counter may be perfectly adequate, and it is therefore felt that such a review is still useful. In addition, large-area single photodiodes have much to offer as X-ray detectors in their own right, and several of the considerations regarding their use in scintillation counters are highly relevant to this application. (author).

28891 (DL/SCI/TM–63E) **Instructions to EXAFS experimenters for using the 13-element germanium detector array.** Morrell, C.; Bilsborrow, R.L.; Derbyshire, G.E. Daresbury Lab. (UK). Dec 1989. 6p. Order Number DE90625164. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The detector array consists of thirteen separate planar high-purity germanium elements in a single cryogenic housing and sharing a common high tension bias supply. Twelve of the elements are used for collecting spectra and one for monitoring. Thirteen sets of signal-processing electronics are used with the array, and each detector element along with its associated electronics is referred to as a 'channel' in this text. It is recommended that before using the array, experimenters should read these instructions, especially those concerning the precautions necessary to avoid damaging the array. The other instructions are about the counting system and setting up procedures. Full specifications of the array are given. (author).

28892 **Recent advances in track physics.** Benton, E.V. (San Francisco Univ., CA (USA). Dept. of Physics); Starace, A.F. (eds.). 144p. Pergamon Press, Oxford, England (1989). Sponsored by U.S. DOE Energy Research; University of Nebraska. DOE Contract FG02-89ER60741. (CONF-8810329–: International conference on recent advances in track physics, Lincoln, NE (USA), 18-20 Oct 1988).

Published in Nuclear Tracks and Radiation Measurements; 16: No. 2/3(1989).

This volume contains the texts of the 17 invited papers presented at the Track Physics Conference held on the campus of the University of Nebraska, in Lincoln, during 18–20 October 1988. The conference brought together researchers from throughout the world who specialize in the study of the structure of particle tracks and its influence upon atomic physics, particle detection, radiation chemistry and radiobiology. Each paper is indexed separately on the energy data base.

28893 (JAERI-M–89-196) **G(E) functions (spectrum-dose conversion operator) of 3"ϕ spherical NaI(Tl) scintillation detector for estimating effective dose equivalent.** Tsutsumi, Masahiro (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Moriuchi, Shigeru; Saito, Kimiaki. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 33p. (In Japanese). Order Number DE90777733. Available from NTIS (US Sales Only), PC A03/MF A01.

With the recommendations of the International Commission on Radiological Protection on limiting exposure to external radiation, the concept of effective dose equivalent has been introduced into the national regulation. For estimating effective dose equivalent, the G(E) functions of the spectrum-dose conversion operators, which evaluate the dose directly from an observed pulse-height spectrum with ease and accuracy, were determined. The NaI(Tl) scintillation detector is spherical one of 3 in. diameter, and the energy range of gamma rays is 40 keV to 3 MeV. For five idealized irradiation geometries, G(E) functions for the effective dose equivalents are presented respectively. Effective dose equivalents used in this calculation are quoted from the data of G. Williams et al. calculated by the Monte Carlo method with anthropomorphic phantoms. The G(E) functions for dose equivalent at 1 cm depth of the ICRU sphere and absorbed dose to air in free air are also represented for comparison. (author).

28894 (JINR–D13-89-548) **Mesooptical microscope as a tomographical device.** Soroko, L.M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 18 Aug 1989. 15p. Sponsored by Joint Institute for Nuclear Research. (CONF-8908224–1: Optoelectronics: Ernst Abbe conference, Jena (German Democratic Republic), 21-26 Aug 1989). Order Number DE90009782. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; JINR, Publishing Dept., Head Post Office, P.O. Box 79 101000, Moscow, USSR.

It is shown that there are at least four regions which are common for the mesooptical microscopes, on the one hand, and for the reconstructed tomography, on the other hand. The following characteristics of the mesooptical microscope show the tomographical properties: (1) the structure of the output data concerning the orientation and the position in space of the straight-line objects going at small angles with the perpendicular to the given tomographic plane, (2) the behaviour of the two-dimensional Fourier-Transform of the straight-line object in the course of the rotation of this object with respect to the specified axis in space, (3) the scanning algorithm of the nuclear emulsion volume by the fence-like illuminated region in the mesooptical microscope for searching for particle tracks going parallel to the optical axis of the microscope, and (4) the fact that the mesooptical images of the straight-line particle tracks with a common vertex in the nuclear emulsion lie on the sinogram. 12 refs., 16 figs.

28895 (JINR–D13-89-549) **Isoplanatic systems in mesooptics.** Soroko, L.M. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 18 Aug 1989. 12p. Sponsored by Joint Institute for Nuclear Research. (CONF-8908224–2: Optoelectronics: Ernst Abbe conference, Jena (German Democratic Republic), 21-26 Aug 1989). Order Number DE90009785. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; JINR, Publishing Dept., Head Post Office, P.O. Box 79 101000, Mowcow, USSR.

The problem of the coma aberration suppression in optics, holography and mesooptics is discussed. A short review of the Abbe sine condition in the holography is given. Then the problem of the isoplanatic system construction in mesooptics is formulated. Its solution in the form of the generalized Abbe sine condition and the Welford theorem concerning the form of the hologram backing is presented. The designs of two isoplanatic mesooptical systems: the Mesooptical Fourier-Transform Microscope for nuclear research emulsion and the Mesooptical Axicon Objective for track chambers in the high energy physics are described. 16 refs., 13 figs.

28896 (JINR–D13-89-550) **Signal-to-noise ratio in the Mesooptical Fourier-Transform Microscope.** Kisvaradi, A.; Molnar, I.; Soroko, L.M.; Tereschchenko, V.V.; Torma, I. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems. 8 Aug 1989. 24p. Sponsored by Joint Institute for Nuclear Research. (CONF-8908224–3: Optoelectronics: Ernst Abbe conference, Jena (German Democratic Republic), 21-26 Aug 1989). Order Number DE90009786. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; JINR, Publishing Dept., Head Post Office, P.O. Box 79 101000, Moscow, USSR.

The character of the noise in the Mesooptical Fourier-Transform Microscope (MFTM) is analyzed and new techniques of amelioration of the signal-to-noise ratio in the MFTM for searching for particle tracks of minimum ionization are treated. Two models of noise in the MFTM are discussed: noncoherent and coherent ones. The illuminating system of the MFTM containing the cylindrical lenses, the electronic-computed device for suppression of the direct components of the noise from background silver grains in the nuclear emulsion, the experimental setup of the noise suppression in the MFTM, the results of the computer simulation of this setup and the results of the experimental test of this equipment for observation of the proton track of energy 650 MeV are described. In conclusion the expected performance of the fast MFTM with a low noise level is presented. 15 refs., 14 figs.

28897 (Juel-Spez–519) **Menu handling in on-line data processing systems shown by the example of the JUSIFA small-angle scattering facility.** Heer, H.; Wagener, M. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Zentrallabor fuer Elektronik. Aug 1989. 76p. (In German). Order Number DE90773574. Available from NTIS (US Sales Only), PC A05/MF A01.

This user manual is meant for first-time users of the JUSIFA facility. It gives information on the login and logout procedure, selection of functions, setup, measuring programs, data analysis and data management. Several menus are graphically presented and explained. (DG).

28898 (KEK–89-5, pp. 12-18) **RIS and detection of isotopes of ultra low abundance.** Miyajima, M. (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Tawara, H.; Sasaki, S. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jul 1989. (CONF-8901178–: 4. workshop on radiation detectors and their uses, Tsukuba (Japan), 24-25 Jan 1989). In *Radiation detectors and their uses.* Order Number DE90741444. Available from NTIS (US Sales Only), PC A08/MF A01.

The report addresses the application of resonance ionization (laser photo-ionization) spectroscopy (RIS) to the detection of radioisotopes of ultra low concentration as a break-through of low level radioactivity measurement. In particular, the study is focused on the detection of ^{135}Xe from a viewpoint of radiation protection. Work has been under way to develop a RIS system for the detection of ^{135}Xe for practical purposes, and other isotopes such as double beta decay products of ^{134}Xe and ^{136}Xe. Outlined here are preliminary results of selective ionization of xenon in which charges of liberated electrons are measured with a single gridded ionization chamber filled with gaseous xenon and a laser system. The ionization chamber is not suitable for the detection of ^{135}Xe in gaseous samples because its concentration is very low and the natural mixtures of xenon isotopes exist as impurities in buffer gas. A mass analyzer is required with RIS to check the deterioration in the uranium target. The mass analayzer is used to measure the differences in isotopic compositions between the mixtures of xenon isotopes in spallation and fission products of ^{238}U and the natural mixtures of xenon isotopes. (N.K.).

28899 (KEK–89-5, pp. 32-44) **Energy resolution in liquid argon doped with allene.** Ichinose, H. (Waseda Univ., Tokyo (Japan). Science and Engineering Research Lab.); Doke, T.; Masuda, K.; Shibamura, E. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jul 1989. (CONF-8901178–: 4. workshop on radiation detectors and their uses, Tsukuba (Japan), 24-25 Jan 1989). In *Radiation detectors and their uses.* Order Number DE90741444. Available from NTIS (US Sales Only), PC A08/MF A01.

Studies have been made on liquid argon as detection medium with large volume and good energy and position resolution. It is advantageous to dope liquid argon with molecules with an ionization potential lower than the energy of scintillation light. In the present work, the energy resolution for 5.305MeV alpha particles is examined, and the effect of allene added to liquid argon is investigated. Some preliminary results for 976 KeV electrons are also presented. Allene is purified by two methods: (a) small-quantity purification and (b) mass purification. Three methods are tried for mixing allene with argon. Results concerning the allene purification methods, effect of allene concentration, and allene-argon mixing methods are presented. Discussion is made of the collected charge and energy resolution. It is concluded that the addition of allene to liquid argon greatly improves the energy resolution of 5.305 MeV alpha particles. The best intrinsic resolution is 1.4 percent FWHM obtained for 4 ppm allene doped liquid argon. In the case of 976 KeV electron radiation, energy resolution is not improved by adding allene to liquid argon. The best resolution is 31 KeV FWHM obtaiend for 65ppm allene doped liquid argon. (N.K.).

28900 (KEK–89-5, pp. 45-51) **Fano factor in rare gases.** Ishida, N. (Waseda Univ., Tokyo (Japan). Science and Engineering Research Lab.); Kikuchi, J.; Doke, T. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jul 1989. (CONF-8901178–: 4. workshop on radiation detectors and their uses, Tsukuba (Japan), 24-25 Jan 1989). In *Radiation detectors and their uses.* Order Number DE90741444. Available from NTIS (US Sales Only), PC A08/MF A01.

Only few measurements have been made of the Fano factor in pure rare gases because of technical difficulties. Three methods are available for measuring the Fano factor: gridded ionization chamber method, proportional counter method and proportional scintillation method. Here, work is done to measure the Fano factor for 5.3 MeV alpha particles in He, He+Ar (1 %), Ar and Xe using a gridded ionization chamber technique developed by Kase. Results are presented and compared with other experimental and theoretical study results. The values of the factor measured are about 25 percent larger than theoretical and experimental values for electrons or X-rays incidence. These discrepancies are expected to be explained by the following two reasons. One is that the values obtained here may contain the nuclear elastic collision effect, which is not included in the theories. The other is that alpha particles produce many secondary electrons whose main component consists of slow electrons, and they increase the Fano factor because the factor becomes larger with decreasing incident electron energy. The contribution of nuclear elastic collisions may be clarified by comparing the values of Fano factor obtained in ^{3}He and ^{4}He. (N.K.).

28901 (KEK–89-5, pp. 52-57) **Properties of self-quenching streamer (SQS) tubes.** Koori, N. (Kyushu Univ., Fukuoka (Japan). Faculty of Engineering); Nohtomi, A.; Hashimoto, M.; Yoshioka, K.; Kumabe, I. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jul 1989. (CONF-8901178–: 4. workshop on radiation detectors and their uses, Tsukuba (Japan), 24-25 Jan 1989). In *Radiation detectors and their uses.* Order Number DE90741444. Available from NTIS (US Sales Only), PC A08/MF A01.

The self-quenching streamer (SQS) mode of gas counters have been widely used for measuring high energy particles. The authors have very recently found that all the rare gas (He, Ne, Ar and Xe) mixtures with quenching gas of CH_4, C_2H_6, C_3H_8, iso-C_4H_{10} or CO_2 can be used as gas mixtures for the SQS mode except Ne- and He-mixtures with CH_4 or CO_2. Further studies on the properties of this mode are needed for its application to monitoring devices. Properties of a self-quenching tube are discussed here from this point of view. Gas multiplication properties, pulse shape of current signals, and dead zone are measured under several gas pressures equal to or less than one atomospheric pressure. Either the SQS or GM mode can be obtained by changing the gas pressure with a cylindrical gas counter. The operation mode of the counter may be correctly determined from the dead zone measurement. The measurements show that the SQS and GM modes are exclusive, even though SQS's can be simultaneously formed with a GM discharge. The counting rate capability of the SQS mode is higher than that of the GM mode by about one order of magnitude. Thus, SQS tubes are suitable for use in high flux radiation fields. (N.K.).

28902 (KEK–89-5, pp. 58-67) **Position sensing with magic gas mixture in the transition region from the proportional to the self-quenching streamer mode.** Uozumi, Y. (Kyushu Univ., Fukuoka (Japan)); Ohgaki, H.; Kubo, R.; Sajima, T.; Motomura, T.; Ijiri, H.; Matoba, M.; Koori, N.; Sakae, T. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jul 1989. (CONF-8901178–: 4. workshop on radiation detectors and their uses, Tsukuba (Japan), 24-25 Jan 1989). In *Radiation detectors and their uses.* Order Number DE90741444. Available from NTIS (US Sales Only), PC A08/MF A01.

The magic gas mixture has been widely used for the operation of multi-wire proportional counters because of its superior features including high gas multiplication, saturation in output pulse height, fast response and limitation of the sensitive area around the anode wire. It is considered that the large output pulse height in the magic gas phenomenon may be due to the self-quenching streamer (SQS) mode. In the present work, position resolution and gas gain measurements are analyzed to study the position sensing with the magic gas mixtures. Position sensing is performed by discriminating pulse height between the proportional, SQS and 2nd SQS mode, using a multi-channel analyzer system. The study covers the gas mixtures of Ar-isoC_4H_{10}-freon13B1 and Ar-CH_4-freon13B1. The larger the freon13B1 concentration, the wider the observed stable region in the SQS mode. In the proportional mode, however, position resolution becomes worse because of a lower S/N ratio. Gas multiplication data suggest that the positive ion density of the discharge in the SQS mode becomes higher by adding a small amount of freon13B1. This fact leads to better position resolution. (N.K.).

28903 (KEK–89-5, pp. 68-74) **Rare-gas dependence of the self-quenching streamer.** Yoshioka, K. (Kyushu Univ., Fukuoka

(Japan). Faculty of Engineering); Hashimoto, M.; Koori, N.; Kumabe, I.; Ohgaki, H.; Matoba, M. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jul 1989. (CONF-8901178–: 4. workshop on radiation detectors and their uses, Tsukuba (Japan), 24-25 Jan 1989). In *Radiation detectors and their uses.* Order Number DE90741444. Available from NTIS (US Sales Only), PC A08/MF A01.

The self-quenching streamer (SQS) mode is understood these days as one of the basic modes of gas counter operation. In the present work, the SQS transition is clearly observed for Ar-, Kr- and Xe-mixtures with CH_4, C_2H_6, C_3H_8, $isoC_4H_{10}$ and CO_2, and for He- and Ne-mixtures with C_2H_6, C_3H_8 and $isoC_4H_{10}$. For He- and Ne-mixtures with CH_4 or CO_2, the GM discharge is developed instead of the SQS transition. The avalanche size at the transition voltage decreases, in the order of He-, Ne-, Ar-, Kr- and Xe-mixtures, except for He-mixtures with CH_4 or CO_2. The mechanisms of the SQS transition proposed by Atac et al. and Zhang have disadvantages in explaining all these results. If the photo-ionization is assumed as in Atac's mechanism, energetic photons whose yield is sufficiently large are needed for the SQS transition. The interaction between metastable states of rare gases proposed by Zhang may be energetically capable of producing electrons for the transition; effects of quenching gas in mixtures cannot be explained by this mechanism. Further investigation is necessary for microscopic processes occurring in the avalanche development. More detailed information is required on the atomic reaction cross sections of photo-ionization, radiative recombination, etc. (N.K.).

28904 (KEK–89-5, pp. 110-117) **A rod-like plastic scintillation detector for use in gamma-ray dosimetry and attempts to attain uniform response.** Yamashita, Mikio (Electrotechnical Lab., Tsukuba, Ibaraki (Japan)); Kawada, Yasushi; Avundukluoglu, M.A. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jul 1989. (CONF-8901178–: 4. workshop on radiation detectors and their uses, Tsukuba (Japan), 24-25 Jan 1989). In *Radiation detectors and their uses.* Order Number DE90741444. Available from NTIS (US Sales Only), PC A08/MF A01.

The paper describes experiments made in an effort to develop scintillation dosimeters with emphasis on some attempts to attain a uniform response over the whole length of scintillators. A new method is proposed for measuring absorbed dose rate in plastic scintillators, using the photon-counting technique for measuring the total amount of luminescence from the scintillator exposed to gamma-rays. If a rod plastic scintillator and lucite light guides with well-polished and non-coated surfaces are surrounded by non-reflective material with a definite air gap between them, the scintillation light is transmitted to the PMTs only by the inner total reflection from the surface; a good uniformity of response could be expected if it were not for light attenuation in the transmission through the medium. With a diffusion reflector in non-optical contact with the scintillator surface, the scintillation light which otherwise would escape from the surface is partly reflected back into the scintillator. This effect is examined quantitatively. Measurements show that the presence of the diffusion reflector permits the uniformity of response to be improved considerably; a uniformity within 20 % is obtained. (N.K.).

28905 (KEK–89-5, pp. 118-125) **A simplified cosmic ray counter.** Akiyama, Nobue (Japan Radiation Engineering Co. Ltd., Hitachi, Ibaraki (Japan)); Aoyama, Takahiko; Minato, Susumu. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jul 1989. (CONF-8901178–: 4. workshop on radiation detectors and their uses, Tsukuba (Japan), 24-25 Jan 1989). In *Radiation detectors and their uses.* Order Number DE90741444. Available from NTIS (US Sales Only), PC A08/MF A01.

The report addresses a study on the feasibility of cosmic ray non-destructive investigation by using a very simplified counter which consists of CsI(Tl) scintillator and photodiode. The intensity of cosmic rays transmitted through material is represented as a function of the shape and density of the material. It is assumed that the cosmic rays penetrate material rectilinearly and that the building has a homogeneous and uniform body. This leads to an equation for the intensity of cosmic rays. With the equation, the bulk density of the material can be estimated from a measured muon intensity if the vertical component of the initial muon intensity is known. The coincidence method is effective to distinguish cosmic rays from terrestrial gamma rays. In a single sensor, cosmic rays from every possible angle can be counted so that the distinctness of the figure may be degraded. Here, an examination is made of a 10 mm cubic CsI(Tl) scintillator and photo-diode as a sensor. Cosmic-rays are measured in a room located on the 1st floor in a 4-storied concrete building. The measured counting rate in the room is in good agreement with a value obtained from a generally used empirical formula. (N.K.).

28906 (KEK–89-5, pp. 126-133) **A neutron detector using silicon pin photodiodes.** Aoyama, Takahiko (Nagoya Univ. (Japan). Faculty of Engineering); Oka, Yasushi; Watanabe; Tamaki. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jul 1989. (CONF-8901178–: 4. workshop on radiation detectors and their uses, Tsukuba (Japan), 24-25 Jan 1989). In *Radiation detectors and their uses.* Order Number DE90741444. Available from NTIS (US Sales Only), PC A08/MF A01.

Silicon pin photodiodes in recent years have been used as detectors for charged particle and low energy X- and gamma-ray spectroscopy instead of conventional surface barrier detectors. This is because pin photodiodes have a higher energy resolution, and the cost required for these purposes is lower. The present paper describes the development of a highly sensitive and small sized neutron detector for personal monitoring using pin photodiodes with a gadolinium-foil neutron converter. A detection efficiency of 3.1 % is obtained for thermal neutrons by detecting internal conversion electrons emitted from a gadolinium-foil converter. Gamma-component contained in the output pulses is cancelled nearly completely by using twin photodiode with tin foil instead of the gadolinium converter. A low detection limit of 240 $cm^{-2}sec^{-1}$ for thermal neutron flux density is obtained under gamma-background with a dose rate of 25 μSv/hr. Since the present neutron detector is also sensitive to gamma-rays, it is suitable to measure the equivalent dose rate in a mixed field of neutrons and gamma-rays. The detector could be useful for the construction of real-time neutron dosimeters. (N.K.).

28907 (KEK–89-5, pp. 134-147) **Neutron field measurements at high energy proton accelerators.** Suzuki, T. (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Noguchi, M.; Oki, Y. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jul 1989. (CONF-8901178–: 4. workshop on radiation detectors and their uses, Tsukuba (Japan), 24-25 Jan 1989). In *Radiation detectors and their uses.* Order Number DE90741444. Available from NTIS (US Sales Only), PC A08/MF A01.

Since the revised Japanese Radiation Protection Law requires that the dose equivalent of neutron be evaluated with double the quality factor, it becomes necessary to review the neutron dose equivalent with the new quality factor. At high energy proton accelerators, stray neutrons are produced mostly at target stations for secondary beam lines and beam dumps. Stray neutrons are also produced by a beam loss along the beam lines. The stray neutrons after penetrating through shields have widely varying energies from thermal to nearly the accelerated proton energies. Here, the Bonner sphere spectrometer and activation detectors are used to obtain neutron energy spectra outside the shield of the EP2 proton beamline in the counter wall at the National Laboratory of High Energy Physics. Results agree well with the calculation by O'Brien and a dose equivalent deduced from the spectrum is also comparable with the regular field monitoring at the Laboratory using a dose equivalent rem counter. In the measurements made, higher energy neutrons than 20MeV are observed and contribute 50 % to the dose equivalent. As a result, it seems reasonable that, in the regular field monitoring with a rem counter, readings of the counter are doubled in evaluating the radiation level in μSv/h. (N.K.).

28908 (KFK–4652) **The Karlsruhe 4π barium fluoride detector.** Wisshak, K.; Guber, K.; Kaeppeler, F.; Krisch, J.; Mueller, H.; Rupp, G.; Voss, F. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Kernphysik; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Hauptabteilung Ingenieurtechnik. Dec 1989. 122p. Order Number DE90780246. Available from NTIS (US Sales Only), PC A06/MF A01.

A new experimental approach has been implemented for accurate measurements of neutron capture cross sections in the energy

range from 5 to 200 keV. The Karlsruhe 4π Barium Fluoride Detector consists of 42 crystals shaped as hexagonal and pentagonal truncated pyramids forming a spherical shell with 10 cm inner radius and 15 cm thickness. All crystals are supplied with reflector and photomultiplier, thus representing independent gamma-ray detectors. Each detector module covers the same solid angle with respect to a gamma-ray source located in the centre. The energy resolution of the 4π detector is 14% at 662 keV and 7% at 2.5 MeV gamma-ray energy, the overall time reslution is 500 ps and the peak efficiency 90% at 1 MeV. The detector allows to register capture cascades with 95% probability above a threshold energy of 2.5 MeV in the sum energy spectrum. Neutrons are produced via the $^{7}Li(p,n)^{7}Be$ reaction using the pulsed proton beam of a Van de Graaff accelerator. The neutron spectrum can be taylored according to the experimental requirements in an energy range from 5 to 200 keV by choosing appropriate proton energies. A collimated neutron beam is passing through the detector and hits the sample in the centre. The energy of captured neutrons is determined via time of flight, the primary flight path being 77 cm. The combination of short primary flight path, a 10 cm inner radius of the spherical BaF_2 shell, and the low capture cross section of barium allows to discriminate background due to capture of sample scattered neutrons in the scintillator by time of flight, leaving part of the neutron energy range completely undisturbed. (orig./HSI).

28909 (LPNHE–89-04) **The multistep chamber as a hardware event buffer.** Astier, P. (Paris-11 Univ., 91 - Orsay (FR). Lab. de Physique Nucleaire et Hautes Energies); Charpak, G.; Dominik, W.; Sauli, F. Paris-11 Univ., 91 - Orsay (France). Lab. de Physique Nucleaire et Hautes Energies. Jun 1989. 15p. (CONF-8905194–: 4. Pisa meeting on advanced detectors: frontier detectors from frontier physics, La Biodola (Italy), 21-26 May 1989). Order Number DE90770336. Available from NTIS (US Sales Only), PC A03/MF A01.

We study a multistep chamber optically read out used as a buffered tracking detector for a tagged neutrino beam.

28910 (NIKHEF-H–89-12) **Three-dimensional computation of magnetic fields and Lorentz forces of an LHC dipole magnet.** Daum, C. (Nationaal Inst. voor Kernfysica en Hoge-Energiefysica (NIKHEF), Amsterdam (Netherlands). Sectie H); Avest, D. ter. NIKHEF-H-Technical University Twente Collaboration. Nationaal Inst. voor Kernfysica en Hoge-Energiefysica (NIKHEF), Amsterdam (Netherlands). Sectie H. Jul 1989. 54p. (LHC-Note–94). Order Number DE90625158. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Magnetic fields and Lorentz forces of an LHC dipole magnet are calculated using the method of image currents to represent the effect of the iron shield. The calculation is performed for coils of finite length using a parametrization for coil heads of constant perimeter. A comparison with calculations based on POISSON and TOSCA is made. (author). 5 refs.; 31 figs.; 6 tabs.

28911 (NUREG/CR–5540) **Performance testing of extremity dosimeters, Study 2.** Harty, R. (Pacific Northwest Lab., Richland, WA (USA)); Reece, W.D.; Hooker, C.D. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Regulatory Applications; Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 85p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC06-76RL01830. (PNL–7276). Available from NTIS, PC A05/MF A01 - GPO; OSTI; INIS.

The Health Physics Society Standards Committee (HPSSC) Working Group on Performance Testing of Extremity Dosimeters has issued a draft of a proposed standard for extremity dosimeters. The draft standard proposes methods to be used for testing dosimetry systems that determine occupational radiation dose to the extremities and the performance criterion used to determine compliance with the standard. Pacific Northwest Laboratory (PNL) has conducted two separate evaluations of the performance of extremity dosimeter processors to determine the appropriateness of the draft standard, as well as to obtain information regarding the performance of extremity dosimeters. Based on the information obtained during the facility visits and the results obtained from the performance testing, it was recommended that changes be made to ensure that the draft standard is appropriate for extremity dosimeters. The changes include: subdividing the mixture category and the beta particle category; eliminating the neutron category until appropriate flux-to-dose equivalent conversion factors are derived; and changing the tolerance level for the performance criterion to provide consistency with the performance criterion for whole body dosimeters, and to avoid making the draft standard overly difficult for processors of extremity dosimeters to pass. 20 refs., 10 figs., 6 tabs.

28912 (ORNL/FTR–3576) **[L* detector as one of the systems proposed for use on the Superconducting Super Collider]: Foreign trip report, February 21–March 01, 1990.** Appleton, B.R. Oak Ridge National Lab., TN (USA). 6 Apr 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009852. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this trip was to initiate the process of preparing an Expression of Interest (EOI) letter or proposal to the Department of Energy for the L* detector as one of the systems proposed for use on the Superconducting Super Collider (SSC) for high energy physics measurements. The L* collaboration involves scientists from many countries and the Moscow meeting was the first of several that will define the roles and responsibilities appropriate for the various participants. The final meeting will be hosted by Oak Ridge National Laboratory (ORNL) on April 26–28, 1990. We also attended a meeting at CERN prior to the Moscow meeting to discuss the magnet system proposed for L* and to hear of the latest physics measurements from the L3 detector located on the LEP accelerator at CERN.

28913 (ORNL/FTR–3585) **[Assembly of phototubes to lead-glass detectors]: Foreign trip report, March 5–April 3, 1990.** Cumby, R.P. Oak Ridge National Lab., TN (USA). 12 Apr 1990. 2p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009850. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler participated in the assembly of phototubes to lead-glass detectors in preparation for stacking into two main frames, 1250 tubes each.

28914 (RAL–89-119) **GUFDIPP - the GUERAP user-friendly data-input programme package for generating and modifying GUERAP III data-files.** Richards, A.G. Rutherford Appleton Lab., Chilton (UK). Nov 1989. 344p. Order Number DE90625165. Available from NTIS (US Sales Only), PC A15/MF A01; OSTI; INIS.

This document describes the GUERAP User-Friendly Data-Input Program Package, called GUFDIPP for short. GUFDIPP is a large suite of programs, developed at RAL (Rutherfield Appleton Laboratory), with the specific purpose of providing a user-friendly interface to the GUERAP III straylight analysis program. GUERAP III is a powerful, Monte-Carlo based program (supplied under licence from ESTEC) for simulating the transfer of electromagnetic radiation between the surfaces of a physical structure and it requires a rather detailed data-set to describe the structure to be modelled. GUFDIPP was developed in order to permit the GUERAP III dataset to be easily, efficiently and accurately built-up and modified, so that access to the GUERAP III program would be much easier, therefore encouraging its use. This document acts as a user-manual for GUFDIPP. Perhaps the most powerful of GUFDIPP's capabilities are those which permit the extraction of subsets of surfaces from a model's datasets to create a new 'sub-model' and the ability to 'add' two models' datasets to create a new 'merged' model. These permit considerable time-saving when entering constraint surface information for a sensor model. (author).

28915 **A neutron streak camera.** Wang, C.L. (Lawrence Livermore National Lab., CA (USA)); Lerche, R.A.; Medecki, H.; Phillips, G.E.; Singh, M.S. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors present the design and construction of a simple neutron streak camera. The cathode is a 10 μm thick U^{238}, 2.5 cm wide and 1.5 mm high, vacuum deposited on a stainless steel substrate which replaces the cathode of a Lawrence Livermore

National Laboratory (LLNL) Model 3 x-ray streak camera. Accompanying a fission fragment, about 200 low energy secondary electrons can be emitted from the cathode. The test of the streak camera at the LLNL rotating target 14 MeV neutron source is in progress. Preliminary results are presented.

28916 Progress or it all depends on your viewpoint. Fairman, W.D. (Occupational Health and Safety Div., Argonne National Lab., Argonne, IL (US)). vp. of Proceedings of the thirtieth annual conference on bioassay, analytical and environmental chemistry. NLO, Inc., Cincinnati, OH (USA) (1985). DOE Contract W-31-109-ENG-38. (CONF-841097–: Facts, paybacks and energy management programs, Baltimore, MD (USA), 15-16 Oct 1984).

Most recent progress within the Argonne Bioassay Group has been in automation and datamation. Other than minor modification in existing procedures and in troubleshooting, relatively little R and D effort has been applied to radiochemistry due to major reductions in personnel and equipment budgets. These reductions have nevertheless provided an extra incentive for automation and encouraged increased inter-group cooperation and sharing of personnel and equipment. Their records management system, which also handles sample scheduling operations, has been improved through the partial automation of laboratory faced, via tape backups, to the main personnel system. An overview of the system and its operation is presented.

28917 The effects of variations in the photocathode voltages of electronic streak cameras. Bowers, M.W. (Lawrence Livermore National Lab., CA (USA)); Biggs, G.L.; Ronchetto, J.J.; Teruya, A.T. pp. 354 of High speed photography, videography, and photonics VI. Stradling, G. L. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract W-7405-ENG-48. (CONF-8808220–: High speed photography, videography, and photonics VI, San Diego, CA (USA), 15-17 Aug 1988).

Electronic streak cameras are used to record subnanosecond data at the Nevada test site. It has been found that externally induced variations in the photocathode voltage of the streak tube can produce both temporal was used to model the magnification as a function of photocathode voltage and signal input position for streak tubes. Laboratory tests were also performed where pulsed and radio frequency signals were induced upon the photoccathode and the errors on the resultant image were compared with the error predicted by the electron beam code. Also, methods of processing the distortion in digitized images were investigated. This paper discusses the results of these investigations.

28918 Resolution limitations and optimization of the ITT F4157 streak tube focus for 10-ps operation. Grasz, E.L. (Lawrence Livermore National Lab., CA (USA)); Lerche, R.A.; Griffith, R.L. pp. 354 of High speed photography, videography, and photonics VI. Stradling, G.L. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract W-7405-ENG-48. (CONF-8808220–: High speed photography, videography, and photonics VI, San Diego, CA (USA), 15-17 Aug 1988).

The authors studied the focusing properties of an ITT F4157 image tube that was biased at voltages far from the original design and is used for operation in an ultrafast (10 ps) streak camera. Its output resolution at streak camera operating potentials was measured as a function of input slit width, incident-light wavelength, and focus-grid voltage, with results similar to those reported for the RCA C73435 streak tube. The temporal resolution is insensitive to focus-grid voltage for a narrow (50um) input slit, but is very sensitive to focus-grid voltage for a wide (500 um) input slit. Spatial resolution is nearly independent of focus-gird voltage for valves that give good temporal resolution. Both temporal and spatial resolution depend on the incident-light wavelength. Streak camera operation is simulated with a computer program that calculates photoelectron trajectories. Electron ray tracing describes the observed effects of slit width, incident-light wavelength, and focus-grid voltage on the output resolution.

28919 Veiling glare in the ITT F4113 image intensifier. Wiedwald, J.D. (Lawrence Livermore National Lab., CA (USA)); Hertel, R.J. pp. 354 of High speed photography, videography, and photonics VI. Stradling, G. L. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract W-7405-ENG-48. (CONF-8808220–: High speed photography, videography, and photonics VI, San Diego, CA (USA), 15-17 Aug 1988).

Users of the ITT F4113 proximity-focused image intensifier tube have generally been unable to obtain its specified resolution when using it to amplify streak tube images. As well as reduced high-frequency resolution, some output light can be detected at distances as great as a few millimeters from the input image. This long-range light spreading is called veiling glare. In this paper the authors propose the cause of the F4113's veiling glare. The most probable cause is electron scattering at the front surface of the microchannel plate, with some contribution due to electron scattering at the phosphor. Some improvements have recently been made to the F4113. These are described and possible additional improvements are suggested.

4402 Radiation Effects on Instrument Components, Instruments, or Electronic Systems

Refer also to citation(s) 28520, 28587, 28590, 28810, 28812, 28827, 29791

28920 (JAERI-M–89-207) **Irradiation effect of transistor by Co-60 gamma rays and electron beams: Effects of exposure rate and temperature.** Hirao, Toshio (Japan Atomic Energy Research Inst., Takasaki, Gunma (Japan). Takasaki Radiation Chemistry Research Establishment); Yoshikawa, Masahito; Morita, Yosuke; Kaiga, Hideaki; Yata, Masanobu. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 135p. (In Japanese). Order Number DE90777752. Available from NTIS (US Sales Only), PC A07/MF A01.

In order to evaluate radiation resistance of semiconductor devices which are used in radiation environments of artificial satellites and nuclear power plants, effects of radiation on the DC gain, leak current and switching time of typical transistor devices were investigated. Tested devices are PNP bi-polar transistor (2SB603), NPN bi-polar transistor (2SC764) and power MOS transistor (2SK458). Irradiation were carried out by Cobalt-60 gamma rays and electron beams of 1 and 2 MeV at exposure rates ranging from 10^2 to 10^6 R/h, and at temperature ranging from -40degC to 100degC. The following results were obtained. (1) 2SB603: Changes of the DC gain and leak current are larger in low exposure rate irradiations, and large exposure rate dependency is observed. The DC gain change is based on mainly increase of the base current. The exposure rate dependency is observed in the reverse saturation current and voltage, but in the switching time. (2) 2SC764: The exposure rate and temperature dependencies on irradiation effect are not clear, and the radiation resistance is over two orders higher than 2SB603 in the various properties. (3) 2SK458: The exposure rate and temperature dependencies on irradiation effect are small. (4) Irradiation effect on 2SB603 by electron beams is smaller than that by gamma-rays, and the exposure rate effect is observed. No difference between electron beams and gamma rays is observed for 2SC764 and 2SK458. (author).

28921 A spin dependent recombination study of radiation induced defects at and near the Si/SiO_2 interface. Jupina, M.A. (Pennsylvania State Univ., University Park, PA (US)); Lenahan, P.M. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA)*, 36(6): 1800-1807 (Dec 1989). Contract DNA002-86-0055. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

A new electron spin resonance technique, spin dependent recombination (SDR) permits extremely rapid, high signal to noise ratio electron spin resonance (ESR) measurements of electrically active radiation damage centers in (relatively) hard MOS transistors in integrated circuits. Using SDR the authors observe the radiation induced buildup of Pbo and E' centers at relatively low concentration in individual MOSFETs in integrated circuits with (100) silicon surface orientation. Earlier ESR studies of extremely large (~1 cm^2) capacitor structures have identified Pb and E' centers as the dominant radiation induced defects in MOS devices. The authors

discuss how their results extend and confirm these earlier results and at least qualitatively answer objections to the earlier work related to the relevance of large capacitor studies to transistors in an integrated circuit.

28922 Correlation between preirradiation 1/F noise and postirradiation oxide-trapped charge in MOS transistors. Schofield, J.H. (Physics Dept., Oberlin College, OH (US)); Doerr, T.P.; Fleetwood, D.M. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 36(6): 1946-1953 (Dec 1989). (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

The authors have preformed a detailed comparison of the preirradiation 1/f noise and the radiation-induced threshold voltage shifts due to oxide-trapped and interface-trapped charge, δV_{ot} and δV_{it}, for enhancement-mode, 3μ gate, n-channel Mos transistors taken from seven different wafers processed in the same lot. These wafers were prepared with gate oxides of widely varying radiation hardness. The authors show that the preirradiation 1/f noise levels of these devices correlate strongly with the postirradiation δV_{ot}, but not with the postirradiation δV_{it}. These results suggest that 1/f noise measurements may prove useful in characterizing and predicting the radiation response of MOS devices.

28923 An improved standard total dose test for CMOS space electronics. Fleetwood, D.M. (Sandia National Lab., Albuquerque, NM (US)); Winokur, P.S.; Riewe, L.C.; Pease, R.L. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 36(6): 1963-1970 (Dec 1989). DOE Contract AC04-76DP00789. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

The postirradiation response of hardened and commercial CMOS devices is investigated as a function of total dose, dose rate, and annealing time and temperature. Cobalt-60 irradiation at $\simeq$ 200 rad(SiO_2)/s followed by a 1-week 100°C biased anneal and testing is shown to be an effective screen of hardened devices for space use. However, a similar screen and single-point test performed after Co-60 irradiation and elevated temperature anneal cannot be generally defined for commercial devices. In the absence of detailed knowledge about device and circuit radiation response, a two-point standard test is proposed to ensure space surviability of CMOS circuits: a Co-60 irradiation and test to screen against oxide-trapped charge related failures, and an additional rebound test to screen against interface-trap related failures. Testing implications for bipolar technologies are also discussed.

28924 Radiation response of floating gate EEPROM memory cells. Snyder, E.S. (Sandia National Lab., Albuquerque, NM (US)); McWhater, P.J.; Dellin, T.A.; Sweetman, J.D. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 36(6): 2131-2139 (Dec 1989). DOE Contract AC04-76DP00789. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

The effect of radiation on a floating gate EEPROM nonvolatile memory cell is determined experimentally and modeled analytically. The new model predicts the threshold voltage change resulting from radiation. A screen based on the initial 1 state (excess electron) threshold voltage is shown to be necessary to assure data retention during irradiation. Techniques to increase radiation hardness are also described. The hardness of floating gate cells is shown to be limited to less than 100 krad(Si) for a fixed reference sense amplifier. The use of a differential sense amplifier may increase this limit. Therefore, floating gate memories should be useful for those applications requiring low total-doses.

28925 CMOS VLSI single event transient characterization. Heileman, S.J. (Univ. of Florida, FL (US)); Eisenstadt, W.R.; Fox, R.M.; Wagner, R.S.; Bordes, N.; Bradley, J.M. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 36(6): 2287-2291 (Dec 1989). Grant ECS-8451221. (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

This paper reports single-event upset (SEU) transient measurements made on test structures developed using the MOSIS IC fabrication service. Three test structures were designed for a CMOS p-well 3μ process, including two MOS diodes for SEU transient measurements. Devices were irradiated with 5 MeV boron ions 5 MeV α particles.

28926 Circumvention of radiation-induced noise in CCD and CID imagers. Yates, G.J. (Los Alamos National Lab, Los Alamos, NM (US)); Turko, B.T. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 36(6): 2214-2222 (Dec 1989). (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

Measurements of radiation sensitivity for interline transfer charge-injection devices (CIDs) from irradiation with high-energy photons (^{60}Co gammas and 3- to 5-MeV end-point Bremsstrahlung) and 14 MeV neutrons are presented to establish imager susceptibility in such environments. Results from electronic clearing techniques designed for quick ($\approx$300μs for the CCDs and $\approx$10μs for CIDs) removal (or dumping) of radiation-induced charge from prompt sources are discussed. Application of the techniques coupled with long (microsecond to millisecond) persistence radiation-to-light converters for image retention are described. Typical data illustrating the effectiveness of charge clearing in removal of radiation noise are included for nanosecond duration pulsed x-ray/γ-ray doses (50 millirad to 5-rad range) and microsecond duration neutron fluences approaching 10^8 n/cm^2.

28927 Characteristics of GaAs heterojunction FETs (HFETs) and source follower FET logic (SFFL) inverters exoposed to high energy neutrons. Janousek, B.K. (The Aerospace Corp., Los Angeles, CA (US)); Krantz, R.J.; Bloss, W.L.; Yamada, W.E.; Brown, S.; Remke, R.L.; Witmer, S. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA),* 36(6): 2223-2228 (Dec 1989). (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

This paper reports GaAs heterojunction field effect transistors (HFETs), and inverters and ring oscillators comprising HFETs exposed to neutron fluences of 5 x 10^{13}n/cm^2 to 1 x 10^{15}n/cm^2 to evaluate the characteristics of HFET integrated circuits in a high-energy neutron environment. The HFETs irradiated in this study exhibited pre-irradiation transconductances of approximately 120 mS/mm and threshold voltages of – 0.82 V. The degree of transconductance degradation is similar to that observed in ion-implanted GaAs MESFETs; however, the magnitude of the HFET threshold shift (only 140 mV at a neutron fluence of 1 x 10^{15}n/cm^2) is significantly smaller than that observed in GaAs MESFETs. The neutron-induced threshold shift in GaAs HFETs has been modeled including the effect of pinning the Fermi level at the semi-insulating boundary. Neutron bombardment of source-follower FET logic (SFFL) inverters and ring oscillators comprising HFET devices results in a reduction in high noise margin and an increase in low noise margin with a 35% reduction in ring oscillator frequency at 1 x 10^{15}n/cm^2. These results indicate that more complex HFET SFFL circuits should remain functional at high neutron fluences.

4404 Well Logging Instrumentation

Refer also to citation(s) 27870, 29271, 29272, 29274

4406 Optical Instrumentation

Refer also to citation(s) 27653, 28651, 28770, 28772, 28894, 28895, 28919, 29117, 29909, 29921

28928 (CONF-9004173–2) **Advances in surface-enhanced Raman spectroscopy for applications in real-time subsurface monitoring.** Wachter, E.A.; Ferrell, T.L.; Gammage, R.B.; Vo-Dinh, T.; Haas, J.W. III; James, D.R. Oak Ridge National Lab., TN (USA). [1990]. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From DOE real-time subsurface monitoring of groundwater workshop; Dallas, TX (USA); 17-18 Apr

1990. Order Number DE90009420. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Because of its excellent selectivity and high sensitivity, surface enhanced Raman scattering (SERS)has attracted considerable attention as a potentially powerful analytical tool for detection and screening of trace-level contaminants in groundwater. The narrow Raman bands hold promise for simplifying the identification of individual components in complex mixtures. 10 figs., 5 tabs.

28929 (EGG-M–89047) **Applications of diffraction moire interferometry to the creation of unique identifying marks.** Deason, V.A.; Ward, M.B. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 6p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-8908222–4: 3. international conference on laser interferometry, San Diego, CA (USA), 6-11 Aug 1989). Order Number DE90009764. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

With the development of the portable diffraction moire interferometer, it became possible to imagine the use of subtly distorted or aberrated diffraction gratings as unique markers. The portable system, described in another report, provides a simple and convenient method for accurately measuring the degree of distortion of an aberrated diffraction grating so as to uniquely determine the identity of the grating. The concept, technique, devices, and data reduction are described for this unusual application of diffraction gratings, interferometry, and optical fibers. 2 refs., 7 figs.

28930 (EGG-M–89050) **A compact portable diffraction moire interferometer.** Deason, V.A.; Ward, M.B. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 6p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-8908222–1: 3. international conference on laser interferometry, San Diego, CA (USA), 6-11 Aug 1989). Order Number DE90009780. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This device utilizes single mode polarization maintaining optical fibers to generate the pair of laser beams required by diffraction moire interferometry. Design of the device permits extremely rapid and convenient setup for measurement of in-plane displacement distributions on the surfaces of specimens. The device, applications, and typical data are described. 4 figs.

28931 (EGG-M–90092) **Development of a process control sensor for the glass industry: A status report.** Kramlich, J.C. (Energy and Environmental Research Corp., Irvine, CA (USA)); Gardner, M.; Koppang, R.R. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1990]. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-76ID01570;FC07-89ID12781. (CONF-9003138–1: Sensors Expo west conference, Long Beach, CA (USA), 14 Mar 1990). Order Number DE90009769. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An overview is presented of a program leading to the development of a thermal sensor for the glass industry. The approach makes use of fiber optics for remote sensing and an optical multiplexer to allow economical multipoint, multiple wavelength measurements. A series of three optical approaches are under consideration for various parts of the glass forming process. These generally attempt to make use of the remote, multipoint characteristics of the prototype detector to (1) minimize the interference of reflected background radiation on optical pyrometry measurements, and (2) to use the variations of glass transmission with wavelength to develop a temperature vs. depth characteristic within the melt. 2 refs., 6 figs.

28932 A comparison of flat-field measurement techniques for optical streak cameras. Montgomery, D.S. (Lawrence Livermore National Lab., CA (USA)); Wiedwald, J.D. pp. 354 of High speed photography, videography, and photonics VI. Stradling, G. L. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract W-7405-ENG-48. (CONF-8808220–: High speed photography, videography, and photonics VI, San Diego, CA (USA), 15-17 Aug 1988).

A technique for calibrating the flat-field response and geometric distortion of optical streak cameras using high-power lasers and electro-optic pulse shaping hardware was reported previously. The laser hardware provides a temporarily-flat light pulse that can be used to calibrate streak cameras operating with sweep durations of 3-10 ns. Although this technique is successful, the hardware involved is expensive and the process is complex. Based on the analysis of calibrations made at these fast sweep rates, the authors developed a new technique to measure the flat-field response of an optical streak camera using an array of visible light emitting diodes (LED) and a slow sweep generator. They discuss the new slow technique and present a comparison between calibration measurements made using the two techniques.

28933 Analysis of the Boeing FEL mirror measurements. Knapp, C.E. (Los Alamos National Lab., NM (USA)); Viswanathan, V.K.; Appert, Q.D. pp. 302 of Mirrors and windows for high power/high energy laser systems. Klein, C.A. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-8901159–: Mirrors and windows for high power/high energy laser systems, Los Angeles, CA (USA), 17-18 Jan 1989).

The aberrations have been measured for the finished mirrors that are part of the burst mode ring resonator of the free electron laser (FEL) being constructed at the Boeing Aerospace Company. This paper present analysis of these measurements using the GLAD code, a diffraction ray-tracing code. The diffraction losses within the resonator due to the aberration are presented. The analysis was conducted in two approaches is shown. A proposed solution to the problems caused by the aberrations is presented and analyzed.

28934 A performance evaluation of three high-fidelity streak cameras. Bonlie, J.D. (Lawrence Livermore National Lab., CA (USA)); Lowry, M.E. pp. 354 of High speed photography, videography, and photonics VI. Stradling, G.L. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract W-7405-ENG-48. (CONF-8808220–: High speed photography, videography, and photonics VI, San Diego, CA (USA), 15-17 Aug 1988).

Several scientific programs at Lawrence Livermore National Laboratory (LLNL) require instrumentation that can capture optical signals with high fidelity. Typically, they require high temporal resulution, high spatial resolution, and high dynamic range.The instrument of choice for most of these multichannel, data-recording applications is the optical streak camera. The authors have evaluated three optical streak camera systems under similar conditions: the EG and G model L-CA-15 streak camera, designed and built under U.S. Department of Energy (DOE) contract, with a streak tube that operates in the extraction mode; and a Thomson-CSF model TSN 506 streak camera, with an ITT F4157 streak tube that also operates in the extraction mode. All three systems were found to be capable of time response better than 40 ps FWHM, a dynamic range of greater than 100, and spatial resolution greater than 5 line pairs per millimeter (lp/mm). The experimental setup and plots of results are presented and discussed.

28935 Acoustic damage to large-aperture optics. Smith, J.R. (Lawrence Livermore National Lab., CA (USA)); Murray, J.R.; Kyrazis, D.T.; Wilcox, R.B.; Weiland, T.L.; Ehrlich, R.B.; Thompson, C.E.; Engle, R.B.; Brown, A.E. pp. 302 of Mirrors and windows for high power/high energy laser systems. Klein, C.A. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-8901159–: Mirrors and windows for high power/high energy laser systems, Los Angeles, CA (USA), 17-18 Jan 1989).

The authors have observed damage to 80-cm-diam fused-silica disks and lenses subjected to high-fluence pulses (up to 2.3 j/cm^2) from an upgraded Nova laser beamline (wavelength 351 nm; pulse duration 2.35 ns; beam diameter 70 cm; energy up to 8 kj). Damage occurred in the center of each element, where a 6-cm-wide obscuration prevented direct illumination. They believe that light strongly scattered by transverse stimulated Brillouin scattering (SBS) interacts with the surface and with the bulk of the substrate, producing two kinds of acoustic waves that propagate to its center, where they become strong enough to do damage. In the surface interaction, scattered light is absorbed by an 0-ring near the perimeter of the optic, creating a Rayleigh wave that propagates along the surface to the center of the optic. The resulting damage takes the form of crater-shaped fractures about 8 mm in diameter and 4 mm deep. They propose design rules for avoiding acoustic damage in large optics and compare observed thresholds for transverse SBS with predictions in the literature.

28936 Measurements of optical loss in transparent solids using a novel spectrometer based on optical cavity decay. Milanovich, F.P. (Lawrence Livermore National Lab., CA (USA)); Hunt, J.T.; Roe, J.N. pp. 302 of Mirrors and windows for high power/high energy laser systems. Klein, C.A. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-8901159–: Mirrors and windows for high power/high energy laser systems, Los Angeles, CA (USA), 17-18 Jan 1989).

Recent advances in high average power (HAP) solid state lasers and the development of new concept lasers with the potential of ultra-high average power output have put increasing demands on the transparency of optical window materials. To gain a better understanding of the current status of window materials and to direct research towards more nearly transparent materials, the authors have constructed an optical characterization facility with the purpose of making quantitative optical loss measurements in the sensitivity range of 10-3 to 10-6 cm-1. The cornerstone of this facility is a scanning optical lossmeter in which loss is determined by comparing the decay time of an optical cavity with and without a transparent solid present. The lossmeter has been applied to measurements of the optical loss of witness samples of highly transparent fused silica. A description of the lossmeter and a compilation of preliminary loss measurements are presented.

28937 A novel alignment technique for pointing and centering optical components. Ellis, R.J. (Lawrence Livermore National Lab., CA (USA)). pp. 277 of Current developments in optical engineering III. Fischer, R.E.; Smith, W.J. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract W-7405-ENG-48. (CONF-8808213–: Current developments in optical engineering III, San Diego, CA (USA), 15-18 Aug 1988).

A relatively simple technique was devised to precisely align the components of a diagnostic instrument which recorded the first neutron images of imploding laser fusion targets. Alignment was achieved using a laser, a 2 mm diameter glass sphere, and a pair of lenses. With this technique, a 6 cm long aperture was pointed with an accuracy of 68 microradians and coaxially aligned with a target and detector separated by 10.5 meters. The alignment technique is described and critical features are discussed.

28938 Quantitative multispectral imaging system. Bionta, R. M. (Lawrence Livermore National Lab., CA (USA)); Park, H. S.; Cook, K. J. pp. 354 of High speed photography, videography, and photonics VI. Stradling, G. L. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract W-7405-ENG-48. (CONF-8808220–: High speed photography, videography, and photonics VI, San Diego, CA (USA), 15-17 Aug 1988).

Describe an imaging system developed to obtain quantitative multispectral visible images of objects from an airborne platform. The system consists of a multispectral image intensified camera coupled to a real-time image processing system. The image processing system monitors the camera performance in flight. In this article, the authors processing system, the multispectral camera, the calibration procedure and present stellar intensity and spectral measurements.

28939 Comparison of mechanical and electronic high-speed recording systems. Sweatt, W.C. (Sandia Labs., Albuquerque, NM (USA)); Phipps, G.S.; Shagam, R.N.; Hill, R.A. pp. 354 of High speed photography, videography, and photonics VI. Stradling, G.L. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). (CONF-8808220–: High speed photography, videography, and photonics VI, San Diego, CA (USA), 15-17 Aug 1988).

Commercially available mechanical, video, and electronic high-speed imaging systems are compared as part of an attempt to answer the question, will electronic cameras replace film cameras for high-speed recording? Of interest is the relationship between spatial resolution and frame rate. Equally important is the compatibility of the imaging systems for recording different types of experiments and tests. The resolution of a number of systems that represent various classes of framing cameras are compared at their maximum framing rate. Included are several classes of mechanically advanced framing cameras, electronic streak cameras operated in a framing mode, and high-speed video systems. Likewise, the resolution of various classes of streak and image motion cameras are compared at their maximum temporal resolution.

28940 Equivalence of focusing conditions for holographic and varied line-space grating systems. Palmer, C. (Milton Roy Company, Analytical Products Division, 820 Linden Avenue, Rochester, New York 14625 (US)); McKinney, W.R. *Applied Optics (USA)*, 29(1): 47-51 (1 Jan 1990). DOE Contract AC03-76SF00098.

The focal conditions for diffraction grating systems that employ holographic and varied line-space gratings are shown to be formally identical. An example is given in which the recording geometry of a holographic grating is derived that provides the same imaging (to lowest order) as a ruled grating whose grooves, while straight and parallel, vary in spacing across the surface of the grating.

28941 Stable single mode operation of a quasioptical gyrotron. Antonsen, T.M. Jr. (High Power Microwave Electronics Branch, Code 4740, Naval Research Laboratory, Washington, DC 20375 (US)); Levush, B.; Manheimer, W.M. *Physics of Fluids B (USA)*, 2(2): 419-426 (Feb 1990).

The regions in parameter space of stable single mode operation of a quasioptical gyrotron are determined theoretically for a number of configurations. A pencil beam is found to give rise to large operating regimes where single mode operation is stable. These regions shrink dramatically when an annular beam is considered. However, stable operation can be restored by slightly tilting the axis of the cavity.

28942 Root-mean-square emittance increase in a nonlinear lens. Rhee, M.J. (Department of Electrical Engineering and Laboratory for Plasma Research—University of Maryland, College Park, Maryland 20742 (USA)). *Physics of Fluids B (USA)*, 2(2): 452-453 (Feb 1990).

An exact derivation of the root-mean-square emittance increase when a beam of arbitrary distribution passes through a nonlinear lens system is presented. It is found that the emittance increase depends on the spherical aberration coefficient of the lens and characteristics of the beam distribution.

4408 Miscellaneous Instrumentation

Refer also to citation(s) 27531, 27580, 27601, 27602, 27604, 27605, 27609, 27618, 27619, 27620, 27623, 27625, 27626, 27628, 27630, 27631, 27632, 27638, 27639, 27643, 28068, 28593, 28672, 28762, 28791, 29315, 29692, 29700, 29707, 29708, 29709, 29712, 29713, 29714, 29715, 29716, 29717, 29731, 29732, 29733, 29734, 29736, 29737, 29739, 29744, 29745, 29746, 29748, 29757, 29764

28943 (BNL-NUREG–44386) **Dynamic strain gages analysis of critical welds used in power plant circuit breakers.** MacDougall, E.A. (Brookhaven National Lab., Upton, NY (USA)); Wilhelm, W.G. Brookhaven National Lab., Upton, NY (USA). [1990]. 8p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC02-76CH00016. (CONF-900599–5: 36. ISA international instrumentation symposium, Denver, CO (USA), 6-10 May 1990). Order Number DE90009524. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A history of failures in power plant circuit breakers associated with critical welds in the internal pole shafts has been investigated. This paper describes the test, equipment, and instrumentation and summarized the preliminary results of testing performed on these breakers at Brookhaven National Laboratory. It includes the description of the instrumentation including the use of a full bridge strain gage sensor and instrumentation amplifier connected to an oscilloscope. The combination provided a sensitive instrument capable of revealing subtle changes in circuit breaker performance. The strain gages were attached to pole shafts and monitored dynamically. The observed changes in wave signature were recorded as a function of accumulated operating cycles. Complex changes in wave shape recorded on an oscillograph indicate patterns related to impending weld failure. The life expectancy measured in the number of circuit breaker open and closing cycles is compared with the weld and other component failures. 8 refs., 4 figs.

28944 (CGA–CE02953, pp. 372-376) **Features of electronic correctors.** Ensch, R. (Dresser Measurement, Houston, TX (USA)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

This paper discusses the performance, accuracy, calibration and safety aspects of electronic intergration (EI). Electronic intergrators must maintain high levels of accuracy under severe environmental conditions and still be able to be manufactured at a reasonable cost. There are two basic types or categories of inteceptors. The first type is an instrument that is physically attached to, or is an integral part of, the gas meter. The second type is an instrument that is located at a remote location from the metering device. The main performance specifications for EI include the following: accuracy, linearity repeatibility, low hysterysis error, ambient temperature effect operating temperature range, storage temperature range, supply voltage effect, and supply voltage range. An understanding of calibration, testing, and maintenance procedures, of limitations imposed by device powering schemes and of safety features and requirements are vital in evaluating EI equipment.

28945 (CGA–CE02953, pp. 351-364) **Fundamental of SCADA [Supervisory Control and Data Acquisition] systems.** Tornquist, E. (BC Gas Inc., Vancouver, BC (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

SCADA is an acronym for Supervisory Control and Data Acquisition. It refers to a system that permits users to monitor and control remote facilities from one or several control centres. A SCADA system allows an operator located at a system control centre to make accurate and informed decisions about remote facilities that may be located at opposite ends the country or within sight of the control centre. One of the major juistifications for a SCADA system in the gas distribution field is for its contribution to the efficient contract administration required to meet gas purchase contracts and the protection of public safety. This paper discusses the digital system components, the schematic layout of the system, and various aspects of multiplexing and digital signal transmission on SCADA systems. 4 refs., 9 figs.

28946 (CGA–CE02953, pp. 335-342) **Canadian Meter/Elster gas measurement products.** Poole, J. (Canadian Meter Co. Inc., Milton, ON (Canadian)); Barnett, B. Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

Ruhr Gas is one of the largest natural gas transmission companies in the world , delivering virtually all natural gas from the Soviet Union to Europe. In addition, two meter manufacturers, Elster Meter and Kromschroder are owned by Ruhr Gas. This relationship has led to an agreement between Elster and Canadian Meter whereby Canadian Meter has marketing rights to Elster in Canada. The Elster product line consists of many different types of meters, regulators, instruments, test meter. This paper describes product lines which Canadian Meter is marketing. Product capabilities are described for the Qantometer QA series gas turbine meter, the high pressure diaphragm meter and a variety of computerized data collecting and processing systems. 3 figs., 1 tab.

28947 (CGA–CE02953, pp. 323-330) **Metretek year two at Consumers Gas.** Eagleson, D. (Consumers Gas Co., Toronto, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

In the fall of 1985 Consumers Gas began a pilot project to evaluate the Metretek automatic meter reading system. This pilot project was originally set up to test both the Metretek automatic meter reading system and electronic correctors that would be used in conjunction with the Metretek sytem. The field trail proved both the viability of the Metretek System and the electronic correctors that Consumers had chosen as the preferred method of volume correction. Starting in April of 1988 Consumers began billing using the Metretek system. This paper depicts some of the current and past field installation procedures for the Metretek AMR system used at Consumers. Consumer's Gas uses the Metretek Networked System to collect data from a call-in system. Data is called in twice per day. Data thus collected is stored on a file server on a PC. The stored data is translated and uploaded to the mainframe system in an overnight batch operation. Several edits are performed on the Metretek data before it is passed to the chart calcualtion system. This system has proved to be very reliable and customer response has been good. 1 fig.

28948 (CGA–CE02953, pp. 316-322) **Fundamentals of diaphragm meters.** Albert, N.E. (ICG Utilities (Ontario) Ltd., North Bay, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd, Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

This paper describes the fundamentals of diaphragm meters, covering their history, components and basic operation. The first gas meters were invented in 1815 by Samuel Clegg in England. It was a wet variety of meter which is a water or oiled sealed. It lost popularity because of its cost, failures related to temperature, and the difficulty in maintaining proper liquid levels within the meter. In 1844, Croll and Richard of England invented a two-diaphragm, slide-valve, dry meter. This meter was later perfected by Thomas Glover. In 1903 a three chamber diaphragm meter was invented. Diaphragm meters are still popular today. The diaphragm meter consists of four main components; the diaphragm which acts as a measuring container, the valve and seal, the tangent, and the index a simple mechanical gear ration device that measures the gas flow. The operation of four chamber diaphragm meter, temperature compensated diaphragm meters and three chamber diaphragm meters is described. 3 refs.

28949 (CGA–CE02953, pp. 468-480) **Latest technology in moisture measurement.** Kunz, N. (Stephens Equipment Inc., Oakville, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

The need for accurate determination of water content of natural gas is critical to producers, distributors and end users alike, in order that quality control be maintained. Moisture measurement is a difficult task under ideal conditions when using conventional instrumentation such as chilled mirror, (Bureau of Mines Dewpoint Tester), electrolytic and aluminum oxide technology. When the quality of gas changes, such as sudden slugs of moisture, glycol, particulates or other contaminants, accurate measurement becomes virtually impossible due to inherent characteristics of the aforementioned technologies. The advent of the M.C.M. silicon chip sensors and new moisture calibration genertors has not only addressed the problems associated with conventional technology but has allowed meaningful hygrometer evaluations to be conducted. Silcon chip moisture detection is compared with chilled mirror, electolytic, oscillating crystal and aluminum oxide tests. This technology eliminates frequent down-time and inaccuracy formerly associated with measurement of very moist gases. 7 refs., 3 figs.

28950 (CGA–CE02953, pp. 455-467) **ELSA a family of electronic correctors.** Barnett, B. (Canadian Meter Co, Inc., Milton, ON (Canada)). Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement

school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

The ELSA electronic corrector is a complete system for use on all gas meters with an instrument drive output. The ELSA is battery powered and completely self contained including the volume switching and pressure transducer. The housing is cast aluminum, weather resistant, and secured with several tamper proof features. ELSA receives volume input from the meter via a rotating shaft with uncorrected values between 5 and 1000 ft./rev. or alternately it will accept pulses from a user supplied contact closure. The shaft rotation, which can be in either direction is immediately digitized by four switches operating in sequence. The digitized volume is fed directly to the micromprocessor based digital computer which is simultaneously receiving pressure and temperature imputs from the transducers. The microprocessor digitally computes the corrected volume by applying the pressure and temperatue factors, along with compressibility to the uncorrected volume and up-dates a digital display of corrected volume every 32 seconds. Included in this report is a detail description of ELSA and the remote data acquisition system designed for use with micro-or main frame computers. 3 figss., 4 tabs.

28951 (CGA–CE02953, pp. 425-447) **Development of Canadian meters automatic meter reading system.** Poole, J. (Canadian Meter Co., Milton, ON (Canada)); Barnett, B. Canadian Gas Association, Don Mills, ON (Canada). [1990]. (CONF-8906313–: 28. annual gas measurement school, London (Canada), 13-15 Jun 1989; CE–02953). In *Proceedings of the twenty-eighth annual gas measurement school.* Available from Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST.

This paper describes the components of an radio frequency (RF) automatic meter reading system as well as design objectives and benefits. By using an RF system to read meters, a utility company greatly improves its data collecting capability and its relationship with the customer. The company also increases the accuracy of reads by eliminating the human error factor and also it increases its efficiency by increasing the number of meters read per day per meter reader. The RF system provides several advantages over a telephone system. First, no telephone lines need to be run to the meters, thus decreasing installation costs and decreasing the possibility of vandalism. Secondly, an RF system eliminates any involvement with the phone company, including installation costs, tariffs, line charges and regulations. Finally, if eliminates down-time which would be incurred when the telephone system experiences service intenrruption. 1 fig.

28952 (EGG-M–90028) **A hydrogen transient nuclear magnetic resonance sensor for industrial drying applications.** Nicholls, C. Southwest Research Inst., San Antonio, TX (USA). [1990]. 9p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-76ID01570. (CONF-9003138–2: Sensors Expo west conference, Long Beach, CA (USA), 14 Mar 1990). Order Number DE90009616. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

It has been estimated that industrial non-paper drying processes consume ~0.8 quad (i.e. 8×10^{14} BTU) of energy per year in the United States, representing ~5% of total industrial consumption. If improved technologies could be used to increase the efficiencies of the drying process and hence produce a 2% reduction in energy consumption, the energy savings would be 0.016 quad per year, or ~2.5 million bbl of crude oil. DOE studies indicated that the most attractive R&D target to aid in achieving these savings was an advanced moisture sensor, capable of application to a wide variety of drying processes. To meet these objectives the sensor should accurately monitor product moisture content over the range 2–35 % wt moisture (wb) and be usable at temperatures up to 350°F. 22 refs., 11 figs., 1 tab.

28953 (JAERI-M–89-205) **Development of the remote-controlled electrical resistance measurement apparatus.** Hoshiya, Taiji (Japan Atomic Energy Research Inst., Oarai, Ibaraki (Japan). Oarai Research Establishment); Takada, Fumiki; Kizaki, Minoru; Sudo, Kenji; Sakakura, Atsushi; Ichihashi, Yoshinori; Den, Shoji. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 80p. (In Japanese). Order Number DE90777742. Available from NTIS (US Sales Only), PC A05/MF A01.

A remote-controlled electrical resistance measurement apparatus with a variable-temperature control has first been developed to understand changes in transformation characteristics of shape memory alloys after irradiation. Both isochronal and isothermal annealing experiments (post-irradiation experiments) have been carried out for irradiated Ti-Ni shape memory alloys intimately associated with shape recovery capabilities by using this apparatus. Form in-service testing results of this apparatus, it was shown that from the view point of the handling or reliability of the apparatus, a temperature control method using the simple specimen-driving system was best suited for the remote-controlled measurement on physical properties of specimens, because of no use of semiconductors or temperature sensors to be highly sensitive to gamma ray irradiation and that it was applicable to other remote-controlled apparatuses. And thus, experimental results were obtained from electrical resistance measurements that electrical resistance of irradiated shape memory alloys markedly changed during neutron irradiation and revealed the negative temperature dependence and that those alloys are very sensitive to the neutron irradiation and that they have the damage-restoration effect. Furthermore, it makes clear that the newly developed remote-controlled electrical resistance measurement is quite a simple measuring method and can be used for the study of phase transformation materials to be associated with the structure-sensitivity, which are inclined to be influenced by neutron irradiation. (J.P.N.).

28954 (KCP–613-4302) **Small strain gage applications 2.** Wenski, E.G. Allied-Signal Aerospace Co., Kansas City, MO (USA). Kansas City Div. Mar 1990. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00613. (CONF-9006124–1: Society for Experimental Mechanics conference, Albuquerque, NM (USA), 4-6 Jun 1990). Order Number DE90008312. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper describes a number of small strain gage applications conducted recently at Allied-Signal Inc., Kansas City Division. These stress analyses used some of the smallest strain gages commercially available on the market today. Although data reduction techniques remain the same for these small-scale analyses, gaging techniques differ from application to application. This paper discusses three different strain gage applications using 0.015 grid area strain gages. 9 figs.

28955 (N–90-15545) **Superconducting gravity gradiometer mission. Volume 1: Study team executive summary.** Morgan, S.H.; Paik, H.J. National Aeronautics and Space Administration, Huntsville, AL (USA). George C. Marshall Space Flight Center. Aug 1989. 42p. (NASA-TM–4091-VOL-1;NAS–1.15:4091-VOL-1). Available from NTIS, PC A03/MF A01.

An executive summary is presented based upon the scientific and engineering studies and developments performed or directed by a Study Team composed of various Federal and University activities involved with the development of a three-axis Superconducting Gravity Gradiometer integrated with a six-axis superconducting accelerometer. This instrument is being developed for a future orbital mission to make precise global gravity measurements. The scientific justification and requirements for such a mission are discussed. This includes geophysics, the primary mission objective, as well as secondary objectives, such as navigation and tests of fundamental laws of physics, i.e., a null test of the inverse square law of gravitation and tests of general relativity. The instrument design and status along with mission analysis, engineering assessments, and preliminary spacecraft concepts are discussed. In addition, critical spacecraft systems and required technology advancements are examined. The mission requirements and an engineering assessment of a precursor flight test of the instrument are discussed.

28956 (PNL-SA–17849) **Field monitoring equipment development and deployment.** Fishbaugher, M.J. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. (CONF-9004134–2: Field monitoring for a purpose conference, Gothenburg (Sweden), 2-5 Apr 1990). Order Number

DE90009453. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Pacific Northwest Laboratory (PNL) has developed field monitoring technology as part of its continuing research for the US Department of Energy (DOE) and the utility industry. PNL has found that successful completion of field monitoring studies depends on precise definition of data requirements and careful selection of equipment and data processing systems. Project size dictates the level of required automation. 4 refs., 1 tab.

28957 (SAND–89-0461) **Laboratory evaluation of the PCP Large Reaction Volume Ion Mobility Spectrometer (LRVIMS).** Schellenbaum, R.L.; Hannum, D.W. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 37p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010230. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The PCP, Inc. Large Reaction Volume ion Mobility Spectrometer (LRVIMS) was characterized and evaluated for use as a contraband explosives vapor detector in personnel and package portal screening applications. The limit-of-detection was found to be a constant ~0.3 PPT experimentally and in calibrations using a Thermedics RDX generator. The minimum LOD in terms of RDX vapor molecular flow rate was $\sim 1.8 \times 10^9$ molecules/sec at 16.6 L/min airflow through the 100 cm^2 square tube area of this ion mobility spectrometer. Samples of 0.5 gm of TNT in plastic bags in the center of the personnel screening portal were easily detected. Bomb quantity (8 oz) samples of TNT and Comp B (40% TNT, 60% RDX) were also detectable in the personnel portal configuration. No detections of RDX were possible in any position of either C-4 or Comp B or of PETN in Detasheet or Det Cord. Operation in the presence of observed background interferants, operation at very low airflow rates, and proposed operation in conjunction with preconcentrators, also are described. 14 figs.

28958 (SAND–90-0050C) **Phase Doppler droplet sizing: Scattering angle effects.** Ceman, D.L.; O'Hern, T.J.; Rader, D.J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9006155–1: ASME fluid measurements and instrumentation conference, Toronto (Canada), 4-7 Jun 1990). Order Number DE90009571. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The phase Doppler technique is an LDV-based method for the nonintrusive, simultaneous measurement of particle size, velocity, and concentration. It is becoming a standard device for measurement of spray droplets in air as well as cavitation nuclei bubbles in water. The Phase Doppler Particle Analyzer (PDPA) is a commercial phase Doppler instrument. Previous calibrations of the PDPA using well-characterized liquid droplets have revealed nonlinearity of the instrument response for droplet diameters less than 20 μm. For many applications, droplet sizing accuracy in the small diameter range is critical. Light scattering calculations performed by the instrument manufacturer suggest two theoretical approaches to improving the instrument response in this size range: optimizing the collection angle and increasing the collection area. The first approach has been tested experimentally. This paper presents size calibrations of the PDPA with the receiver configured at two angles: 30° (the standard configuration) and 70° off-forward axis. The calibration was performed with monodisperse oleic acid droplets in the diameter range 3.7 to 32 μm. As in earlier calibration studies, the 30° configuration resulted in marked nonlinearity in instrument response below 20 μm. Oscillations were still apparent for the 70° configuration, which showed only a modest improvement compared to the response at 30°. 7 refs., 5 figs.

28959 (SAND–90-0906C) **Characterization and calibration of coordinate measuring machines.** Pace, C.F. Sandia National Labs., Albuquerque, NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9005157–1: Methods and equipment of metrology equipment, Milwaukee, WI (USA), 7-9 May 1990). Order Number DE90009320. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

With the increasing use of three axis coordinate measuring machines (CMMs) for product acceptance, part characterization and/or part inspection, there is a corresponding need for acceptable methodologies to calibrate CMMs. Potential error sources in CMMs include scale errors and geometric imperfections as well as possible errors arising from environmental factors such as excessive vibrations or thermally induced structural changes. Although numerous methods for the calibration of CMMs have been reported, this paper will review two calibration methods. The first method is the American Standard for performance testing of CMMs and the second method is a parametric calibration with error compensation of CMMs. Whereas the first method can be used to evaluate the performance of two or more CMMs or for periodically checking a CMM. The second method is more advantageous for the calibration of high accuracy CMMs operating in controlled environments. 11 refs.

28960 RMS and average errors resulting from low pass filter characteristics in instrumentation systems. Destefan, D. (Rockwell International Aerospace Operations, Golden, CO (US)). pp. 584 of Proceedings of the IEEE instrumentation and measurement technology conference. IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8904110–: IEEE instrumentation and measurement technology conference, Washington, DC (USA), 25-27 Apr 1989).

Rectangular and step-line waveforms occur in many physical systems. These waveforms are passed through sensors or signal conditioners having, in many cases, low pass filter characteristics. Further, the filtered waveforms are sampled by A/D converters and the average or rms values calibrated. This work presents the effects of the low pass filter characteristics on the average and rms values of these step-like waveforms. The analysis method used is presented. By way of example, this method is applied to a measurement problem and the results provided. The effects of assuming unit step excitation rather than physically realizable exponential step inputs are also discussed. Future work in this area is suggested.

28961 Two-dimensional coupled-mode theory for modeling leaky-mode arrays. Hadley, G.R. (Division 1164, Sandia National Laboratories, Albuquerque, New Mexico 87185 (US)). *Optics Letters (USA)*, 15(1): 27-29 (1 Jan 1990). DOE Contract AC04-76DP00789.

The use of a two-dimensional coupled-mode theory for modeling buried-ridge-waveguide index-guided arrays in general and leaky-mode arrays in particular is described. This formalism provides a framework for understanding the complicated modal structure of leaky-mode arrays by expressing their modes as linear combinations of the two-dimensional modes of the buried-ridge waveguides and the active-region confinement structure. As a result, the inherently large parameter space of these devices may be collapsed dramatically so that the device behavior is describable in terms of only the propagation constant mismatch between the buried-ridge modes and the active-region modes and their coupling coefficient.

28962 Stable mirror mount. Cutburth, R.W. To Dept. of Energy, Washington, DC. USA Patent 4892283/A/. 9 Jan 1990. Filed date 16 Jun 1988. USA Patent Application 7-207,894. Int. Cl. A47B 23/00. vp.

This patent describes a mirror mount for supporting a mirror where the mirror is oriented in an x-ray plane. The mirror mount comprising post assembly means for supporting the mirror, first keyway means for orienting the post assembly means such that the post assembly means are slidable only in a first direction parallel to a y-axis orientation, and including first screw holes, nut plate means for supporting the first keyway means and including second screw holes, second keyway means for supporting the nut plate means such that the nut plate means are slidable only in a second direction normal to the first direction and parallel to an x-axis orientation such that the post assembly means and the nut plate means are each slidable in a plane parallel to the x-y plane, and locking means normal to the x-y plane including a single screw type locking member movable in a third direction orthogonal to the first and second directions between a first position through the first and second screw holes for simultaneously locking in a single step in clamping engagement the first and second keyway means.

45 MILITARY TECHNOLOGY, WEAPONRY, AND NATIONAL DEFENSE

Refer also to citation(s) 28091, 29932

28963 (CONF-9006165–1) **Motion planning for the Universal Self-Deployable Cargo Handler (USDCH).** Sousk, S.F. (Army Belvoir Research Development and Engineering Center, Fort Belvoir, VA (USA)); Pin, F.G.; Crane, C.D. Oak Ridge National Lab., TN (USA). [1990]. 14p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. From U.S. army science conference; Durham, NC (USA); 12-15 Jun 1990. Order Number DE90009860. Available from NTIS, PC A03/MF A01 - OSTI.

Belvoir Research, Development and Engineering Center (Belvoir) is developing advanced material handling equipment for sustaining material requirements of Airland Battle-Future. In particular, Belvoir is developing a rough terrain forklift truck, the Universal Self-Deployable Cargo Handler (USDCH), that also is called ATLAS. USDCH program approach allows interaction between the operator and the automated controlling systems, while progressively adding robotics, artificial intelligence, and automated methods. Major challenges involve the development of methodologies to provide real-time operations in hostile field environments and to exploit human-machine synergism for maximum efficiency and reliability. This paper reports on robotic motion planning for two major functions of the USDCH: platform mobility and motion of the material handling arm. Novel approaches were necessary to automate the basic motion of the platform and the arm. The algorithms for positioning the platform at a work area are presented and results showing optimum trajectories of the vehicle are given. These results show that the methodologies and algorithms developed are applicable to a wide class of vehicles. 3 refs., 7 figs.

28964 (UCRL–21237) **Engagement analysis study: Final report.** Lawrence Livermore National Lab., CA (USA); Science Applications International Corp., Orlando, FL (USA). 29 Sep 1989. 67p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90009529. Available from NTIS, PC A04/MF A01 - OSTI.

The Missile Systems Division of Science Applications International Corporation (SAIC) originally entered into a subcontract with Lawrence Livermore National Laboratories (LLNL) in April of 1987. This subcontract was for a period of one year. Work on this effort was reported in "MaRV Engagement Analysis Study, Final Report" Dated 25 April 1988. This subcontract was later extended through 30 September 1989. The engagement analysis effort since the initial report is documented herein. This work has been in two phases, and supported LLNL in guidance and engagement analysis efforts of interest to them. The initial efforts consisted of analysis of a ground launched midcourse phase interceptor. During the later phases of the subcontract, emphasis shifted toward an innovative space based engagement concept. Both efforts are documented in this report. Part 2 of this report includes the results of simulation modifications and guidance analyses performed under DOD Subcontract to BDM Corporation, Prime Contract Number SDIO 84-88-C-0017. Additional case runs and the 6DOF results were generated under this LLNL subcontract. 37 figs., 4 tabs.

4501 Chemical Explosions and Explosives

Refer also to citation(s) 28752, 28957

28965 (AD-A–216848/2/XAB) **Nonlinear finite-difference simulations of cavity-decoupled explosions in salt and tuff. Report for 23 March 1987-22 March 1989.** Stevens, J.L.; Murphy, J.R.; Rimer, N. S-Cubed, San Diego, CA (USA). 30 Jun 1989. 68p. (SSS-TR–89-10755). Available from NTIS, PC A04/MF A01.

Nonlinear finite difference simulations are performed to model the seismic source functions for decoupled, partially coupled, and overdecoupled explosions in air-filled cavities in salt and unsaturated tuff emplacement media. The tuff simulations are performed in an 11 meter cavity under conditions similar to the Mill Yard experiment. The salt simulations are performed in a 17 meter cavity under conditions similar to the Sterling test. The maximum low frequency decoupling factor in the tuff simulations is approximately 40. The low value of the decoupling factor is the result of the low shear modulus and poor tamped coupling of this material. The maximum decoupling factor is nearly twice as large as would be expected for a linear material model because the shock wave induces pore crushing that leads to a substantial loss of energy in the nonlinear case. An important result of this research is that the low frequency source amplitude increases very slowly as the yield is increased above the yield required for full decoupling. At high frequencies, there is little difference between simulations with linear and nonlinear material models for decoupled or partially coupled explosions, except for attenuation due to pore crushing.

28966 (UCRL–21109) **Conventional weapons demilitarization: A health and environmental effects data-base assessment: Explosives and their co-contaminants: Final report, Phase 2.** Layton, D.; Mallon, B.; Mitchell, W.; Hall, L.; Fish, R.; Perry, L.; Snyder, G.; Bogen, K.; Malloch, W.; Ham, C. Lawrence Livermore National Lab., CA (USA). Dec 1987. 402p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. Order Number DE90009440. Available from NTIS, PC A18/MF A01 - OSTI; GPO Dep.

To support studies of the health and environmental risks of such by-products, this report presents assessments of data available on parameters that affect the risks posed by explosives and their principal co-contaminants. Specifically, data-base assessments cover factors that influence the transport and fate of the contaminants in environmental media (e.g., soils, water, etc.) and subsequently, human exposures via different pathways (e.g., inhalation, ingestion, and skin absorption). Information on dose-response relationships for various toxic effects in humans and laboratory animals is evaluated so that acceptable daily intakes for noncarcinogenic substances and virtually safe dose rates for carcinogenic substances can be defined. Toxic effects on plant and aquatic species are also addressed. The explosives and co-contaminants considered include TNT (co-contaminants: 2,4-dinitrotoluene; 2,6-dinitrotoluene, 1,3-dinitrobenzene, 1,3,5-trinitrobenzene, 2-amino-4,6-dinitrotoluene, and 4-amino-2,6-dinitrotoluene); RDX (co-contaminant: HMX); tetryl (co-contaminant: picric acid); PETN; and ammonium picrate (co-contaminant: picric acid). 358 refs., 12 figs., 92 tabs.

28967 (UCRL–102467) **The effects of material properties and confinement on DDT.** Lee, E.L.; Weston, A.M.; Aldis, D.F. Lawrence Livermore National Lab., CA (USA). 13 Mar 1990. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9004147–4: 1990 JANNAF propulsion systems hazards meeting, Laurel, MD (USA), 3-5 Apr 1990). Order Number DE90009943. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have used a DDT numerical code, RDUCT, to evaluate the effect of material properties and confinement on DDT in porous beds. RDUCT is a 1-D solid and gas two phase hydrodynamic program that computes deflagration to detonation transition in porous beds, using and "ignition and growth" type reaction model in a solid phase Lagrange coordinate system. The calculation model contains tamper masses at both ends of the reacting bed and is ignited by a squib at one end. Here RDUCT is used to compute the growth of reaction in porous bed inside a rigid tube. The input parameters are varied to produce changes in ignition, burn rate, and confinement. The results of this study illustrate the great sensitivity of the DDT phenomenon to these basic parameters. Implications to modelling and to practical problems of hazard are discussed. 15 refs., 19 figs., 2 tabs.

28968 (UCRL-JC–103107) **Generic initiation train for IHE [insensitive main charge explosive] fuzing.** Lee, R.S.; Weingart, R.C.; Berg, J.D. Lawrence Livermore National Lab., CA (USA). Mar 1990. 15p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-9003142–1: 1990 joint government/industry symposium on insensitive munitions technology, White Oak, MD (USA), 13-14 Mar 1990). Order Number DE90009944. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The insensitive munitions now under development in the Department of Defense (DOD) complex will require fuzes which do not compromise the safety afforded by the use of insensitive main charge explosives (IHEs). At the same time the fuzes must provide

a stimulus which is robust enough to override the higher shock initiation threshold and the probably-larger critical diameter and corner-turning distance of the IHE. Design of the initiation train is critical to the safety of an IHE fuze in abnormal environments and to its proper functioning for initiating IHE. It would be particularly useful to develop design criteria for an initiation train which could be used generically in IHE munitions. The goal of our study was to demonstrate the feasibility of designing an initiation train which does not compromise the safety of an IHE main charge in abnormal thermal environments, i.e., fast and slow heating tests. 1 ref., 13 figs.

4502 Nuclear Explosions and Explosives

Refer also to citation(s) 27766, 28157, 28158, 28159, 28160, 28161, 28162, 28163, 28164, 28165, 28988

28969 (AD-A-216922/5/XAB) **Nuclear winter: A brief review and comments on some recent literature.** Deirmendjian, D. Rand Corp., Santa Monica, CA (USA). Jan 1988. 22p. (RAND/P-7233). Available from NTIS, PC A03/MF A01.

This is a follow-up to a memo on the subject of nuclear winter (NW), a term introduced by the so-called TTAPS authors in their elaboration (Turco, et al., 1983) of an original study by Crutzen and Birks (1982) on the climatic effects to be expected after a major nuclear conflict. A number of related new studies, reviews, comments, and discussions have since appeared in print. The present piece is a slightly expanded version of a brief review of–and commentary on–this literature originally incorporated in another internal RAND memo (Deirmendjian, 1985). What follows is a brief review with comments on some of the more recent NW-related literature. These notes do not by any means represent a complete and detailed analytical review of the current literature on NW work.

28970 (SAND-89-2382C) **Active primary lithium thionyl chloride battery for artillery applications.** Baldwin, A.R. (Sandia National Labs., Albuquerque, NM (USA)); Delnick, F.M.; Miller, D.L. Sandia National Labs., Albuquerque, NM (USA). [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9006146-3: 34. international power sources symposium, Cherry Hill, NJ (USA), 25-28 Jun 1990). Order Number DE90009511. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Sandia National Laboratories and Eagle Picher Industries have successfully developed an Active Lithium Thionyl Chloride (ALTC) power battery for unique artillery applications. Details of the design and the results of safety and performance will be presented. 1 ref., 5 figs.

4503 Nuclear Explosion Detection

Refer also to citation(s) 28113

28971 (AD-A-216641/1/XAB) **Deterministic modeling of regional wave forms from the Nevada Test Site. Final report, 5 September 1988-5 March 1989.** Burdick, L.J.; Saikia, C.K.; Helmberger, D.V. Woodward-Clyde Consultants, Pasadena, CA (USA). 19 Jul 1989. 84p. (WCCP-R-89-01). Available from NTIS, PC A05/MF A01.

Time domain waveform modeling studies of short period P_{nl} and high frequency P_n have been carried out in an attempt to improve event discrimination capabilities with regional data. The purpose was to develop discriminants with a well understood physical basis which could be reliably transported to different areas of the world. The study of P_{nl} involved adapting methods developed to fit long period data for observations with periods as short as two seconds. To accomplish this, we have modified the wavenumber integration method for efficient computation of P_{nl}. Velocity gradients like those typically observed near the free surface were of great importance. Gradients at lower depths such as at the crust-mantle transition are of much less significance. A simple layered model which accurately predicts regional P_{nl} propagation from NTS to the surrounding digital stations were developed. It deterministically explains the waveshape of the P_n and approximately the first 15 seconds of high amplitude energy reflecting past critical angle from the mantle. The modeling study of short period P_n has led to the development of an effective and physically based regional discriminant; the underlying purpose of this project. It has been found that the waveshape of the P_n is stable, similar at most stations and straightforward to model.

28972 (AD-A-216864/9/XAB) **Numerical modeling of Pn geometric spreading and empirically determined attenuation of Pn and Lg phases recorded in eastern Kazakhstan. Semiannual technical report No. 1, 1 January-30 June 1989.** Sereno, T.J. Science Applications International Corp., San Diego, CA (USA). Aug 1989. 124p. (SAIC-89/1555). Available from NTIS, PC A06/MF A01.

The overall goal of this work is to estimate the detection and location capability of actual and hypothetical networks of stations and arrays in and around the Soviet Union. These estimates require the simulation of the detection and location capability of the networks. This report summarizes two studies of important issues involved in the normalization of the simulations. The first is a theoretical study of the dependence of Pn geometric spreading on the velocity gradient in the upper mantle. This is important because most methods for estimating Pn attenuation require assumptions regarding geometric spreading. The second study is an empirical parameterization of regional wave spectra recorded near the eastern Kazakhstan nuclear explosion test site. The results are compared to results from a similar parameterization of data recorded by the NORESS array in Norway. Data recorded by the NORESS and ARCESS arrays are plentiful and provide an excellent basis for normalizing the simulations. Data recorded in eastern Kazakhstan are relatively few at this time, but can be used to see if the NORESS/ARCESS data can be used as a reasonable representation of conditions in this area.

4504 Nuclear and Radiological Warfare

28973 (UCRL-53944) **The role of bombers in a START-reduced force environment with strategic defense.** Barish, F.D. Lawrence Livermore National Lab., CA (USA). 13 Sep 1989. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008185. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The large reduction in strategic forces that may take place over the next several years, coupled with the potential deployment of some type of strategic defense, raises many questions with regard to the desirability of various elements of these forces. This report considers the relative role played by manned bombers in such a reduced force structure. It is shown that a key element in understanding this issue is the ratio of the number of critical targets to weapons for each side. Relative crisis stability is examined for different levels of this ratio. Depending on the ratio and the size of any defensive buildup, bombers can have either a stabilizing or destabilizing effect. In particular, relative crisis stability can be maintained in the early stages of a buildup in strategic defense by allowing for changes in the effectiveness of an existing bomber force. That is, interceptors and bombers could be added simultaneously in some ratio to be determined based on the calculated effectiveness of each. 5 refs., 10 figs., 2 tabs.

4505 Strategic Defense Initiative

28974 (LA-11716-MS) **Scaling of nonnuclear kinetic-energy antisatellites.** Canavan, G.H. Los Alamos National Lab., NM (USA). May 1990. 22p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90009758. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Nonnuclear antisatellites could release particles in the paths of satellites. The antisatellite would have about a twofold mass advantage in attrition and about a tenfold advantage in suppression over the defensive satellite. Antisatellites would weigh 5–10 tons; satellite shields could weigh a factor of 2-4 less. Exchange ratios scale strongly on antisatellite mass, maneuver, and range. Such

antisatellites would be less effective against directed energy satellites, which could clear their paths or destroy the anti-satellites before deployment. 7 refs., 2 figs.

28975 (LA–11752-MS) **Target returns for neutral-particle-beam discrimination.** Canavan, G.H. Los Alamos National Lab., NM (USA). May 1990. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90009759. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Models of weapons and decoys adequate for deposition studies can be formulated and solved analytically. Empirical conversion efficiencies predict useful weapon signals and weapon-to-decoy signal ratios for those energies of interest. Light decoys are of concern because of the numbers possible. Discriminating them on the basis of mass appears feasible with hydrogen or deuterium beams, contrary to earlier studies of much heavier decoys. 8 refs.

4506 Chemical and Biological

Refer also to citation(s) 29102

28976 (AD-A–216160/2/XAB) **Evaluation of the impact of meteorological restrictions on the TEAD Chemical Stockpile Disposal Program. Volume 1. Final report.** Flamm, K.J. Office of the Program Manager, Chemical Demilitarization, Aberdeen Proving Ground, MD (USA). 8 Sep 1989. 205p. (SAIL-PMV–89001A). Available from NTIS, PC A10/MF A02.

This document has been prepared in support of the Tooele Army Depot (TEAD) Site Specific Environmental Impact Statement (SSEIS) for the Chemical Stockpile Disposal Program (CSDP). This study evaluates the impact of TEAD site specific meteorological, geographical and chronological effects on the hazard distances resulting from the Credible Catastrophic Accidents (CCAs) used in the Final Programmatic Environmental Impact Statement (FPEIS). In addition, the study evaluates the impact on the total risk to the public by restricting or partially restricting disposal operations to the portion of the day when stable meteorological conditions do not exist.

28977 (AD-A–216734/4/XAB) **Risk analysis in support of the Chemical Stockpile Disposal Program. Volume 1. Analysis. Final report.** Fraize, W.E.; Cutler, R.; Duff, W.; Hughitt, E.; Perry, J. Mitre Corp., McLean, VA (USA). Civil Systems Div. 17 Dec 1987. 252p. (MTR–87W00230-VOL-1). Available from NTIS, PC A12/MF A02.

See also Volume 2, AD-A216 735.

This document has been prepared for the U.S. Army to support the Final Programmatic Environmental Impact Statement for the Chemical Stockpile Disposal Program (CSDP). This report presents the results of the integrated risk analysis of the CSDP - a continuation of the risk analyses prepared by GA Technologies Inc. for this same program. This report describes the risk analysis methodology, and presents the results of the risk analysis in a variety of ways, including: cumulative risk curves; expected fatalities values; individual risk data; estimates of time and person-years at risk; and, semi-quantitative picto-graphical comparisons of the major measures of both societal and individual risk. Differences in risk of the disposal alternatives are presented and discussed in light of the uncertainty in the analysis.

28978 (AD-A–216735/1/XAB) **Risk analysis in support of the Chemical Stockpile Disposal Program (CSDP). Volume 2. Consequence data.** Fraize, W.E.; Cutler, R.; Duff, W.; Hughitt, E.; Perry, J. Mitre Corp., McLean, VA (USA). Civil Systems Div. 17 Dec 1987. 495p. (MTR–87W00230-VOL-2). Available from NTIS, PC A21/MF A03.

See also Volume 1, AD-A216 734.

No abstract available.

28979 (AD-A–216759/1/XAB) **Chemical Warfare and Chemical/Biological Defense research program obligations. Annual report, 1 October 1987-30 September 1988.** Office of the Director of Defense Research and Engineering, Washington, DC (USA). 1988. 80p. Available from NTIS, PC A05/MF A01.

This report provides funding obligations for the Department of Defense Chemical Warfare-Biological Defense research program.

54 ENVIRONMENTAL SCIENCES

5401 Environmental Sciences, Atmospheric

Refer also to citation(s) 27521, 27696, 27749, 27750, 27943, 27946, 28015, 28020, 28103, 28117, 28144, 28252, 28274, 28276, 28313, 28320, 28321, 28322, 28323, 28324, 28325, 28326, 28327, 28331, 28332, 28355, 28602, 28605, 28611, 28916, 28969, 29048, 29058, 29070, 29075, 29107, 29239, 29249, 29250, 29251, 29268

28980 (AD-A–216690/8/XAB) **Boiler emission compliance survey, Norton AFB, California. Final report.** Attebery, C.W.; Vaughn, R.W. Air Force Occupational and Environmental Health Lab., Brooks AFB, TX (USA). Aug 1989. 176p. (AFOEHL–89-089EQ0144HEF). Available from NTIS, PC A09/MF A01.

At the request of USAF Clinic/SGPB, Norton AFB and HQ MAC/SG PB, compliance testing (carbon monoxide and oxides of nitrogen) of emissions from three Norton AFB boilers was conducted on 17-29 April 1989. Testing was performed to determine compliance with regards to the newly adopted Rule 1146 of the South Coast Air Quality Management District. In anticipation of further regulation. particulate emissions were also determined. Results show that none of the boiler emissions meet the 40 ppm limit for oxides for nitrogen but all meet the 400 ppm limit for carbon monoxide emissions.

28981 (AD-A–216823/5/XAB) **Multiple ignition, combustion, and quenching of hydrocarbon fuel sprays. Annual report.** Aggarwal, S.; Bishop, R.; Sirignano, W.A.; Sommer, H.T. Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Mechanical Engineering. Dec 1981. 8p. Available from NTIS, PC A02/MF A01.

The objectives were to modify the experimental apparatus so that aromatic fuels such as toluene could be included in the program. It was also intended to continue the theoretical analysis of the ignition of gaseous mixtures and to begin the study of the heterogeneous mixture ignition. In the experiments methane and propane air ignition by burning aluminum particles were studied. In this period of research it was of interest to study the ignition limits of mixtures of air with the vapor of a volatile liquid fuel. This information expanded the data base relevant to ignition of liquid fuel sprays by burning metal particles. Theoretical work on the ignition of gaseous mixtures was completed during this period. Both computational and analytical studies were made. Since delivery of the gas mixtures and vapor mixtures to the combustion chamber were fundamentally different, several modifications to the existing apparatus were made to meet the new objectives of the program. It was of interest to be able to obtain a direct measurement of the temperature of the burning particle. Therefore, the possibility of outfitting the experimental apparatus with an optical pyrometer was examined.

28982 (ANL/ER–1) **Review of future plans of the MAP3S Precipitation Chemistry Network: Derived from a MAP3S workshop held April 18–20, 1989, Bethesda, Maryland.** Wesely, M.L. (Argonne National Lab., IL (USA). Environmental Research Div.); McNaughton, D.J.; Artz, R.S.; Gibson, J.H.; Hansen, D.A.; Stedman, D.H. Argonne National Lab., IL (USA). Environmental Research Div. Feb 1990. 59p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90010154. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

A workshop was held in April 1989 to review the future plans of the MAP3S Precipitation Chemistry Network program sponsored by the Department of Energy (DOE). A panel of scientists reviewed options for future activities with regard to meeting the needs of DOE for health and environmental research. The panel concluded that the program should be redirected in the 1990s toward climate change research concerned with the effects of energy-related emissions on the extent of cloud cover and the optical properties of clouds. In addition, the panel found that current operations could be improved, more scientific analysis of the collected data should be conducted, and that the program should be considered as a

means of carrying out future research that might be needed to address new health and environmental issues. 37 refs., 5 tabs.

28983 (BMU–1988-236) **Concepts of computer-aided environmental radioactivity monitoring within the framework of the Integrated Measurement and Information System (IMIS) of the BMU.** Schriftenreihe Reaktorsicherheit und Strahlenschutz. Ergebnisberichte, Untersuchungen, Studien, Gutachten. Schmidt, F. Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.); Stuttgart Univ. (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme. Oct 1988. 85p. (In German). Contract BMU St.Sch. 1088. (IKE–4-128). Available from GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.).

This report contains the contributions of IKE to the design of the Integratedd Measurement and Information System (IMIS). Three contributions are included: 1. the general design of the system, 2. the detailed design of the methods to treat data which are measured by federal authorities; 3. the detailed design for the methods used by the BMU. (orig./HP).

28984 (BNL–44417) **Solving global environmental problems through technological innovation.** Steinberg, M. Brookhaven National Lab., Upton, NY (USA). Mar 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-9002113–1: GISPRI symposium '90 meeting, Tokyo (Japan), 28 Feb 1990). Order Number DE90010018. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Much of the environment problems arise from the supply and utilization of energy for industrial, transportation and domestic markets. The use of fossil fuels can result in environmental, atmospheric, and terrestrial problems, including organic, acid rain, and global warming hazards. Here I will address the CO_2 global greenhouse problem and touch upon the nuclear industry and its dilemma as well. We recognize the possibility of global natural feedback phenomena which may limit and mitigate anthropomorphic global greenhouse climate change, however, here I am limiting the discussion to anthropomorphic (man made) technological mitigation process as opposed to adaptation which means adapting to change.

28985 (CIEMAT–635) **Measurement of radon daughters in air samples by alpha spectroscopy.** Acena, M.L.; Crespo, M.T. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas, Madrid (Spain). 1989. 26p. (In Spanish). Order Number DE90624489. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The concentration of radon progeny in air has been determined by alpha spectrometry measurement of polonium 214 and polonium 218. A known volume of air was passed through a filter, then the alpha activity was directly measured on this filter (Author).

28986 (CONF-9006117–4) **Experimental performance of ozone-safe alternative refrigerants: Experimental performance comparisons of R32, R125, R143a, R218, R134a, R152a, R134, R124, R142b, RC318 and R143 in a refrigeration circuit.** Sand, J.R. (Oak Ridge National Lab., TN (USA)); Vineyard, E.A.; Nowak, R.J. Oak Ridge National Lab., TN (USA). [1990]. 23p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From Annual meeting of The American Society of Heating, Refrigerating and Air-Conditioning Engineers; St. Louis, MO (USA); 9-13 Jun 1990. Order Number DE90009227. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Several compounds proposed as near term or longer range substitutes for the regulated chlorofluorocarbon (CFC) refrigerants were tested in a breadboard vapor-compression circuit, and their performance was evaluated relative to more commonly used refrigerants. The limited physical property information available in the literature for these alternative compounds was used to fit an equation of state so coefficients of performance (COPs) and capacities calculated from refrigerant property subroutines could be compared to those obtained experimentally. Comparisons of measured and modeled performance are given for 11 alternatives and for R22, R12, and R114. Estimates of compressor efficiency with each refrigerant are provided. Several of the alternatives exhibited better performance than the more widely used refrigerants at some or all of the conditions tested. Ozone-safe, alternative refrigerants that performed better than CFC counterparts at selected conditions are R152a, R143a, R134a, R134, and R142b. 9 refs., 1 fig., 8 tabs.

28987 (DOE/BP/63406–10) **Seasonal weather forecast verification: Final report.** Wade, J.E. (Oregon State Univ., Corvallis, OR (USA). Energy Resources Research Lab.); Walker, S.N.; Baker, R.W. USDOE Bonneville Power Administration, Portland, OR (USA). Div. of Resource Management; Oregon State Univ., Corvallis, OR (USA). Energy Resources Research Lab. Feb 1990. 24p. Sponsored by U.S. DOE Management & Administration. DOE Contract BI79-86BP63406. (BPA–89-31). Order Number DE90009467. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this report is to provide an assessment of how accurate seasonal weather forecasts are at the present and report on the prospects for forecast improvement. The report will discuss how the seasonal forecasts are made and used. The verification scheme used will also be described along with the results of the verification. The results will indicate that the accuracy of seasonal forecasts is not high. However, there is some evidence that forecast skill is better at specific sites and particularly for the winter season. New relationships observed between sea level temperatures, El Niño, and Pacific Northwest climate offer hope of better seasonal forecasts. The scope of this study did not allow investigation of the important aspect of the value of the seasonal forecast. 22 refs., 3 figs., 4 tabs.

28988 (DOE/NV–335) **A radiation briefer's guide to the PIKE Model.** Steadman, C.R. Jr. National Oceanic and Atmospheric Administration, Las Vegas, NV (USA). Weather Service Nuclear Support Office. Mar 1990. 165p. Sponsored by U.S. DOE Defense Programs. DOE Contract AI08-87NV10566. Order Number DE90009575. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Gamma-radiation-exposure estimates to populations living immediately downwind from the Nevada Test Site have been required for many years by the US Department of Energy (DOE) before each containment-designed nuclear detonation. A highly unlikely "worst-case" scenario is utilized which assumes that there will be an accidental massive venting of radioactive debris into the atmosphere shortly after detonation. The Weather Service Nuclear Support Office (WSNSO) has supplied DOE with such estimates for the last 25 years using the WSNSO Fallout Scaling Technique (FOST), which employs a worst-case analog event that actually occurred in the past. The "PIKE Model" is the application of the FOST using the PIKE nuclear event as the analog. This report, which is primarily intended for WSNSO meteorologists who derive radiation estimates, gives a brief history of the "model," presents the mathematical, radiological, and meteorological concepts upon which it is based, states its limitations, explains it apparent advantages over more sophisticated models, and details how it is used operationally. 10 refs., 31 figs., 7 tabs.

28989 (EGG–10617-4101) **The value of on-site sodars versus nearest radiosonde soundings in regional emergency response modeling.** Baskett, R.L. (EG and G Energy Measurements, Inc., Pleasanton, CA (USA)); Nasstrom, J.S.; Lange, R. EG and G Energy Measurements, Inc., Pleasanton, CA (USA). [1990]. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-88NV10617. (CONF-900676–1: 83. annual meeting and exhibition of the Air and Waste Management Association, Pittsburgh, PA (USA), 24-29 Jun 1990). Order Number DE90008956. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Lawrence Livermore National Laboratory's Atmospheric Release Advisory Capability (ARAC) provides real-time emergency response support for accidental radiological releases to the atmosphere at Department of Defense and Energy facilities throughout the country. ARAC uses diagnostic three-dimensional dispersion modeling as its primary emergency response tool. The regional (20–200 km) modeling system is built around the MATHEW (Mass-Adusted THrEe-dimensional Wind field) and ADPIC (Atmospheric Dispersion Particle-In-Cell) models. It is essential for ARAC to know the accuracy and transferability of the MATHEW/ADPIC models to a wide variety of settings and meteorological conditions. Consequently, the models have been evaluated against numerous tracer studies over the last decade. This paper provides some recent case studies of

the model performance with a special focus on the wind input data. Real-time model initialization depends on readily available surface wind and upper air observations. Surface airways observations as well as rawinsonde soundings from civilian and military airports throughout the country provide the basic wind inputs for ARAC's models. ARAC receives and decodes these observations from the Air Force Global Weather center using extensive automated software at the LLNL ARAC Center. All ARAC-supported sites have at least hourly surface wind observations on-site. However, the standard twice-daily rawinsonde locations are frequently outside the modeling domain and may be up to 12 hours old, depending on the time of the calculation. 9 refs., 6 figs., 1 tab.

28990 (GSF–6/89, pp. 33-49) **Production, behaviour and deposition of gaseous, particulate, and droplet-shaped reaction products.** Dlugi, R. (Muenchen Univ. (Germany, F.R.). Meteorologisches Inst.); Meier, U.; Paffrath, M.; Quenzel, H. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Results from field studies to determine fluxes and budgets of different chemical compounds in the area 'Grosse Ohe', National Park 'Bavarian Forest' are presented. All deposition processes are influenced by meteorological, plant physiological and chemical processes. For hydrogen peroxide a flux from the atmosphere is determined but also the production inside the forest was observed. This shows an influence of the chemistry of ozone and monoterpenes. The fluxes of nitric and sulfuric acid are influenced by chemical reactions with ammonia. (orig.).

28991 (GSF–6/89, pp. 135-143) **Dynamics of humic substances in polluted forest sites. Experimental concept and preliminary results.** Beudert, G. (Bayreuth Univ. (Germany, F.R.). Lehrstuhl fuer Bodenkunde und Bodengeographie); Haumaier, L.; Zech, W. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

One of the subjects of the project 'dynamics of humic substances in polluted forest sites' is the effect of acid deposition on fluxes and chemical composition of dissolved organic substances in forest ecosystems. Therefore, concentrations and fluxes of dissolved organic carbon (DOC) are determined in precipitation, throughfall, mineral soil input, and output of two differently polluted and damaged spruce forests. In addition, dissolved organic matter is isolated, fractionated and characterized by ^{13}C NMR spectroscopy and chemical degradation. First results are reported. (orig./MG).

28992 (GSF–6/89, pp. 351-356) **The research concept for investigations of forests of the Northern Alps.** Rennenberg, H. (Fraunhofer-Institut fuer Atmosphaerische Umweltforschung (IFU), Garmisch-Partenkirchen (Germany, F.R.)). Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

High concentrations of photooxidants transported above inversions layers are thought to be responsible for the non-biotic damage to the forests of the Northern Alps. At present this hypothesis is supported (1) by investigations on the atmospheric gas-mixing ratio of atmospheric pollutants, (2) the characteristics of the injury to the trees observed with increasing altitude, (3) the changes in the atmospheric gas-mixing ratio of ozone with increasing altitude, and (4) analysis of the detoxification capacity of spruce needles for toxic oxygen species. The impact of the observed local acidification of the soil as a factor of injury to the trees can presently not be evaluated. (orig.).

28993 (GSF–6/89, pp. 397-405) **Studies on the concentrations and enrichment of potentially phytotoxic organic pollutants in rain, cloud, and fogwater.** Herterich, R. (Bayreuth Univ. (Germany, F.R.). Lehrstuhl fuer Hydrologie); Herrmann, R. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Measurements of organic pollutants in rain, cloud- and fogwater indicate that among other phytotoxic compounds especially nitrated phenols reach deposition rates which can possibly exert harmfull effects on vegetation. We present a highly efficient fogwater collector and a wet deposition sampler for the analysis of organic trace substances. Their arrangement for comparative wet deposition studies in the Alpes and the Fichtelgebirge is shown. Preliminary results show maximum fogwater contaminations up to 2 μmolx1^{-1} for 4-nitrophenol and 4-nitrocresols including both pollutants. At highly exposed mountain sites deposition of these compounds into spruce stands via fogwater can reach several mgxm^{-2} within a period of 10 days. (orig.).

28994 (GSF–6/89, pp. 407-416) **Studies on ozone concentrations in air along two altitudinal transects in the Bavarian Alps and at a research tower in the Bavarian Forest National Park.** Werner, H. (Muenchen Univ. (Germany, F.R.). Lehrstuhl fuer Forstpflanzenzuechtung und Immissionsforschung). Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

In the Seed and Cultivation Department of the University a passive ozoneintegrator has been tested and further developed. The test results of the original model and the improved model were presented, and the latest developments explained. Dry passive collectors up to factor 10 were determined to be more responsive than the moist types. The data were collected along two altitudinal transects on the Wank near Garmisch-Partenkirchen and at a research tower in Bavarian Forest National Park. On the tower and one of the Wank transects continuing measurements are also being made by other research groups and are available to us for comparison. (orig.).

28995 (Juel–2335) **Electrochemical detection and quantification of water-soluble oxidants in the atmosphere.** Gilge, S.; Volz-Thomas, A.; Kley, D. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Chemie 2 - Chemie der Belasteten Atmosphaere. Dec 1989. 60p. (In German). Order Number DE90773655. Available from NTIS (US Sales Only), PC A04/MF A01.

This report describes the development of a new analytical procedure for the measurement of H_2O_2 and other soluble oxidants in the atmosphere. The main goal was to develop an instrument that is light-weight and relatively simple to operate so that it can be flown on meteorological balloons. H_2O_2 and its organic homologues are formed in the atmosphere from the recombination of

peroxy radicals (HO_2 and RO_2). It is thus interesting for the understanding of the radical cycles. Because of its high solubility, H_2O_2 is considered to play an important role in the oxidation of SO_2 to H_2SO_4 in fog and cloud droplets. (orig.).

28996 (LA-UR-90-53) **The ASCOT 1988 valley/tributary interaction study.** Porch, W.M.; Clements, W.E. Los Alamos National Lab., NM (USA). [1990]. 32p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-9006111-1: 5. conference on mountain meteorology, Boulder, CO (USA), 26-29 Jun 1990). Order Number DE90009043. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper describes a regular oscillation observed in nighttime valley air flows under relatively light upper level wind conditions. The period of these oscillations is about 20 minutes with at least one harmonic at about 10 minutes. These oscillations are important to pollutant dispersion in valley flows at night. The strong coherence of tributary flow and main valley oscillations and the fact that tributary oscillations lead valley oscillation indicate the importance of tributaries as major contributors to the cold air flow in valleys. 13 refs., 12 figs.

28997 (ORNL/CDIAC-31) **Global and hemispheric annual temperature variations between 1861 and 1988.** Boden, T.A. (ed.) (Oak Ridge National Lab., TN (USA)); Jones, P.D.; Wigley, T.M.L.; Wright, P.B. Oak Ridge National Lab., TN (USA). Carbon Dioxide Information Analysis Center. Mar 1990. 82p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. (NDP-022/R1). Order Number DE90007993. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Environmental Sciences Division Publication No. 3421.

This document presents two estimates of global and hemispheric annual temperature anomalies, relative to a 1950–79 reference period, for 1861–1988. In one set of estimates the influence of El Niño/Southern Oscillation (ENSO)-related events are considered. Both estimates are based on corrected land and marine data. These data are available free of charge as a numeric data package (NDP) from the Carbon Dioxide Information Analysis Center. The NDP consists of this document and a magnetic tape or floppy diskette containing machine-readable data files. This document provides tabular listings of the annual temperature anomalies, describes how the data were processed, defines limitations and restrictions of the data, and provides reprints of pertinent literature. 13 refs., 2 figs., 2 tabs.

28998 (PB-90-151457/XAB) **Effects of appliance type and operating variables on woodstove emissions. Volume 1. Report and appendices A-C. Final report, June 1987-May 1988.** Burnet, P.G.; Houck, J.E.; Roholt, R.B. OMNI Environmental Services, Inc., Beaverton, OR (USA). Jan 1990. 136p. Available from NTIS, PC A07/MF A01.

See also PB-90-151465.

The report gives results of a project, in support of the Integrated Air Cancer Project (IACP), to provide data on the specific effects of appliance type and operating variables on woodstove emissions. Samples of particulate material and volatile organic compounds (VOCs) were collected. Particulate samples were analyzed for different organic fractions including specific polynuclear aromatic hydrocarbon (PAH) compounds. Inorganic matter on the filters was also analyzed. Results were calculated for pollutant concentrations, emission rates, and emission factors. Twelve test runs were conducted on a conventional stove, and two on a catalyst-equipped stove. Operating variables included fuel type (oak and pine), altitude (80 and 800 m), and burn rate (high and low). Test data were analyzed using analysis of variance and linear regression procedures. Although the data do not show strong statistical significance due to variability of results, some general trends do appear to be present, and conclusions can be drawn as to the effects of various operating variables on woodstove emissions.

28999 (PB-90-151465/XAB) **Effects of appliance type and operating variables on woodstove emissions. Volume 2. Appendices D-F. Final report, June 1987-May 1988.** Burnet, P.G.; Houck, J.E.; Roholt, R.B. OMNI Environmental Services, Inc., Beaverton, OR (USA). Jan 1990. 266p. Available from NTIS, PC A12/MF A02.

See also PB-90-151457.

The report gives results of a project, in support of the Integrated Air Cancer Project (IACP), to provide data on the specific effects of appliance type and operating variables on woodstove emissions. Samples of particulate material and volatile organic compounds (VOCs) were collected. Particulate samples were analyzed for different organic fractions including specific polynuclear aromatic hydrocarbon (PAH) compounds. Inorganic matter on the filters was also analyzed. Results were calculated for pollutant concentrations, emission rates, and emission factors. Twelve test runs were conducted on a conventional stove, and two on a catalyst-equipped stove. Operating variables included fuel type (oak and pine), altitude (80 and 800 m), and burn rate (high and low). Test data were analyzed using analysis of variance and linear regression procedures. Although the data do not show strong statistical significance due to variability of results, some general trends do appear to be present, and conclusions can be drawn as to the effects of various operating variables on woodstove emissions.

29000 (PB-90-154592/XAB) **Institutional directory: Climate-related impacts network.** Krenz, M.E.; Stewart, D.J.; Chavez, B.G. National Center for Atmospheric Research, Boulder, CO (USA). Environmental and Societal Impacts Group. Jun 1989. 272p. Available from NTIS, PC A12/MF A02.

The institutional directory of groups, centers, institutes, and individuals involved in climate-related impacts research is an update of the initial network directory issued in 1985. The original directory had 26 listings; now there are about 160. The directory will be useful in maintaining a vital climate-related impacts research community and in establishing linkages among researchers and institutions. The directory was compiled by sending a questionnaire to all North American recipients of the Network Newsletter and assembling the information from those who responded.

29001 (PB-90-157108/XAB) **Determining the relative toxicity and smoke obscuration of combustion products of mine combustibles. Report of investigations/1990.** De Rosa, M.I.; Litton, C.D. Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center. 1990. 19p. (BUMINES-RI-9274). Available from NTIS, PC A03/MF A01.

Combustible materials, when burned, produce toxic gases and smoke, which may vary dramatically from one material to another, with resultant different total toxicity and smoke obscuration levels. The U.S. Bureau of Mines report presents smoke property data acquired for a variety of mine combustibles and shows that there exists a correlation between the smoke properties, the relative toxicity, and the smoke obscuration levels of those combustibles tested. These correlations can be used to devise simple, standard tests for determining the toxic and smoke obscuration hazards of mine materials during fire.

29002 (PB-90-157512/XAB) **Monitoring of atmospheric particles and ozone in Sequoia National Park: 1985-1987. Final report.** Cahill, T.A. California Univ., Davis, CA (USA). Crocker Nuclear Lab. Jun 1989. 76p. Available from NTIS, PC A05/MF A01.

The Air Quality Group Monitored particles and ozone in Sequoia National Park as part of an effort to understand the impact of acid deposition and other air pollutants on the park's forests and watersheds. For high-elevation ozone measurement, the project developed a new solar-powered ozone monitoring system. The particulate matter sampled was analyzed for elemental content using nuclear techniques. The measurements were correlated with meteorology, known elemental sources, and wet and dry deposition measurements. The results show that particulate matter at Sequoia National Park is similar to that present at other sites on the western slope of the Sierra Nevada range at equivalent elevations. Some anthropogenic species, including nickel and sulfate, are present in higher concentrations at Sequoia than at Yosemite National Park.

29003 (PB-90-159112/XAB) **Chlorofluorocarbons (CFCs) and halons. Directive.** Kibler, D. Office of the Under Secretary of Defense (Acquisition), Washington, DC (USA). 13 Feb 1989. 6p. (DOD-D-6050.9). Available from NTIS, PC A02/MF A01.

The Directive establishes policy and assigns responsibilities for the management of CFCs and halons in the Department of Defense (DoD); the identification of CFC and halon applications and

prioritization of their uses; the long-term process of decreasing DoD dependence on CFCs and halons because of reduced availability in future years due to recently promulgated international and domestic production limits; research and development programs to develop or evaluate suitable substitutes for halons and other mission-critical CFC applications; and a tracking system to document DoD's annual requirements for CFCs and halons.

29004 (PB–90-160003/XAB) **Locating and estimating air emissions from sources of 1,3-butadiene. Final report.** Buchanan, S.K. Radian Corp., Research Triangle Park, NC (USA). Dec 1989. 161p. Available from NTIS, PC A08/MF A01.

To assist groups interested in inventorying air emissions of various potentially toxic substances, EPA is preparing a series of documents to compile available information on sources and emissions of these substances. The document deals specifically with 1,3-butadiene. Its intended audience includes Federal, State and local air pollution personnel and others interested in locating potential emitters of 1,3-butadiene and in making gross estimates of air emissions therefrom. The document presents information on the types of sources that may emit 1,3-butadiene, process variations and release points that may be expected within these sources, and available emissions information indicating the potential for 1,3-butadiene releases into the air from each operation.

29005 (PB–90-161068/XAB) **Conversion feasibility of the KILnGAS Commercial Module (KCM) to a hazardous-waste facility: A preliminary assessment.** Nakles, D.V.; Spanaus, D.D.; Garside, P.G.; Banks, R.R. Remediation Technologies, Inc., Pittsburgh, PA (USA). May 1989. 71p. Available from NTIS, PC A04/MF A01.

The study presents the results of a preliminary assessment of the feasibility of converting an existing kiln facility, the KILnGAS Commercial Module (KCM) in East Alton, Illinois, to a hazardous waste incinerator. The study examined the RCRA and Superfund waste volumes and characteristics as well as the treatment and disposal capacity of the State of Illinois to identify potential incineration capacity shortfalls. A centerline waste, soils contaminated with PCBs, was selected to provide a reference case to study the facility conversion. A conceptual facility design was developed using the technical and environmental criteria for the selected waste as a design basis. Major process equipment was identified, sized, and priced. A heat and material balance was developed for a centerline mode of operation to forecast performance. Economics for waste treatment were examined based upon a range of competitive tipping fees and other parameters impacting commercial viability. Finally, tentative conclusions regarding feasibility of the facility conversion are presented and a next step action plan is outlined to corroborate the technical, economic, and regulatory assumptions and to examine design alternatives with the potential for reducing facility costs and/or enhancing its performance or siting potential.

29006 (PB–90-161837/XAB) **Health-hazard evaluation report HETA 89-155-1979, Arcade Parking Garage, Providence, Rhode Island.** Kaiser, E.A. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Aug 1989. 17p. (HETA–89-155-1979). Available from NTIS, PC A03/MF A01.

The Arcade Parking Garage, in Providence, Rhode Island, was evaluated for possible hazardous health conditions due to the presence of carbon monoxide fumes. The garage has nine parking levels, eight above ground. The building was constructed of reinforced poured concrete and the above ground parking spaces were open to the outside, allowing the free circulation of air. Environmental monitoring consisted of carbon monoxide and carbon dioxide air sampling in a collection booth and in the office. The results of the short and long term air sampling indicated exposure to carbon monoxide ranging from 17 to 103 parts per million (ppm). Carbon-dioxide levels were measured at greater than 1000 ppm in the office area, indicating inadequate ventilation. The carbon dioxide levels were all well below the industrial standard of 5000 ppm, but were above the 1000 ppm indoor air quality guideline. Measurements for thermal comfort indicated temperatures were between 62 and 65 F, with relative humidities ranging from 28.3 to 43.7%. These thermal-comfort values were within the guidelines for human occupancy. The reported symptoms of the employees were consistent with carbon monoxide exposure. A potential health hazard existed due to carbon monoxide. Measures to minimize employee exposures are recommended.

29007 (PB–90-161845/XAB) **Health-hazard evaluation report HETA 89-142-1981, Seagull Industries, West Balm Feach, florida.** Roper, P. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Aug 1989. 16p. (HETA–89-142-1981). Available from NTIS, PC A03/MF A01.

Seagull Industries for the Disabled, Inc., West Palm Beach, Florida was evaluated for exposure to silica dust and lead paints in the ceramics area and to solvents in the assembly building. Seagull Industries is a private, nonprofit corporation providing job training and employment, primarily for the mentally regarded. Airborne lead concentrations at the facility were extremely low, ranging from 0.9 to 1.8 micrograms per cubic meter of air (microg/cu m). However, the settled dust on the painters' table tops was 10% lead, which posed some concern for accidental ingestion. Silica exposures in the ceramics polishing area were more significant with measurements of 48 and 64 microg/cu m for the 6 hour work period. If these exposures were adjusted for an 8 hour time weighted average, the levels would be equivalent to 36 and 48 microg/cu m which was slightly less than the National Institute for Occupational Safety and Health recommended limits. Solvent vapor concentrations were minimal during the cleaning of the printing press, due to the fact that there was sufficient natural ventilation. Silica dust levels were significant, and lead dust on table tops may present an ingestion hazard. Measures to control silica and lead exposures and to reduce fire hazards associated with the use of flammable solvents are recommended.

29008 (PB–90-162447/XAB) **In-depth survey report of Roadway Express, Inc., Toledo, Ohio.** Zaebst, D.D.; Ringenburg, V.; Sanderson, W. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 9 Sep 1989. 48p. (IWS–146.22). Available from NTIS, PC A03/MF A01.

An in-depth survey was conducted at Roadway Express, Inc., Toledo, Ohio to determine relative exposures to diesel aerosols among the four major presumably exposed job groups of road drivers, local drivers, dock workers, and mechanics. Element carbon sampling results at the Roadway terminal in Toledo, Ohio, during cold weather indicated low level exposures only slightly above geometric mean ambient residential and highway background concentrations in road drivers and local drivers. Exposures were significantly above background highway concentrations in dock workers and in mechanics, with exposures of 29 and 58 micrograms/cubic meter (microg/cu m), respectively. The highest levels of exposure were to mechanics working in the shop. Exposure to nitrogen oxides and respirable particulates were far below recommended limits. The major source of exposures in dock workers appeared to be the operation of diesel powered fork lift trucks on the dock. The principal source in mechanics was the entry and egress of diesel tractors to and from the shop area, but the more enclosed environment in which they were working exacerbated concentrations of diesel aerosols.

29009 (PB–90-162462/XAB) **Determination of asbestos levels in a public building located in Towson, Maryland.** Wallingford, K.M.; Bierbaum, P.J.; Dement, J.M. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Field Studies and Clinical Investigations. 25 May 1973. 18p. Available from NTIS, PC A03/MF A01.

In response to a request from the Baltimore County Health Department, a study was made of possible exposures to asbestos in a public building in Towson, Maryland. Determinations were made of asbestos in bulk ceiling samples and airborne samples. The building had two levels. The ground level houses the local fire department and the basement level houses the Bureau of Civil Defense. Asbestos was applied to the ceiling of the basement level to help alleviate a heat problem caused by the heating facility located on the ground floor, directly above the civil defense offices. The material, Spraycraft Asbestos Fiber, was applied in two layers. The x-ray diffraction study of the bulk ceiling sample indicated a chrysotile asbestos content of 27%, by weight. Concentrations in airborne samples ranged from 0.0 to 0.0031 fibers/milliliter, which were quite low compared to the 1976 standard 8 hour exposure of

2 fibers/milliliter. Due to the potential for flaking of the ceiling material with subsequently increased employee exposure, the authors recommend that appropriate action be taken to prevent this from occurring.

29010 (PB–90-164526/XAB) **Evaluation of the RADM (Regional Acid Deposition Model) gas-phase chemical mechanism. Final report, September 1987-January 1989.** Carter, W.P.L.; Lurmann, F.W. California Univ., Riverside, CA (USA). Statewide Air Pollution Research Center. Feb 1990. 408p. Available from NTIS, PC A18/MF A03.

Results are presented of a program to independently evaluate the gas phase mechanism developed for use in the second version of the Regional Acid Deposition Model (RADM-II). The RADM mechanism was tested by comparing predictions against results of over 550 environmental chamber experiments carried out at the University of California at Riverside and at the University of North Carolina. Statistical summaries of the overall results and results for individual experiments are presented and discussed. A series of 90 test problems for use in sensitivity calculations to assess effects of alternative assumptions for gas-phase mechanisms used in regional models was also developed and used to test several condensation approaches for the RADM mechanism. As a result of the evaluation against chamber data and the sensitivity test calculations, recommendations were made for modifications to the RADM mechanism. Two modified RADM mechanisms, one involving primarily changes in parameter values and one where more extensive changes and use of fewer model species are involved, were developed. These modified mechanisms and their performance in simulating the chamber data and the sensitivity test problems are discussed.

29011 (PB–90-164542/XAB) **Effects of hydroxymethanesulfonate on airway function in subjects with asthma. Final report.** Sheppard, D.; Balmes, J.R.; Aris, R.M.; Christian, D. California Univ., San Francisco, CA (USA). Lung Biology Center. 30 Jun 1989. 43p. Available from NTIS, PC A03/MF A01.

The organic ion hydroxymethanesulfonate (HMSA) has been measured in micro-molecular concentrations in acidic fogs in southern California. HMSA is a stable adduct in fogs with a pH range of 3-5, but it is likely to dissociate at pH 6.6, the pH of the human airways fluid lining. It was hypothesized that HMSA may have a specific bronchoconstrictor effect because HMSA may dissociate in the airway lumen generating SO_2 and CH_2O, both of which have bronchoconstrictor potential. In order to determine whether HMSA has such an effect, a total of 19 subjects with mild to moderate asthma were studied in an exposure chamber in which freely breathing and exercising subjects inhaled simulated fogs containing HMSA at a concentration (1000 micro M) higher than the ambient levels for 1 hour. The results indicated no significant bronchoconstrictor effect for acute exposures of HMSA.

29012 (PB–90-164831/XAB) **Annual report on performance audit results for POHC (Principal Organic Hazardous Constituents) testing during RCRA (Resource Conservation and Recovery Act) trial burns. Status report No. 2.** Jayanty, R.K.M.; Tompkins, S.B.; Bryant, V.R.; Howe, G.B. Research Triangle Inst., Research Triangle Park, NC (USA). Dec 1989. 68p. Available from NTIS, PC A04/MF A01.

See also PB–89-161970.

Audit materials containing Principal Organic Hazardous Constituents (POHSc) have been developed by AREAL for use by federal, state, and local agencies or their contractors to assess the accuracy of measurement methods during Resource Conservation and Recovery Act (RCRA) trial burn tests. Audit materials are currently available for 27 gaseous organics in 5, 6, 7, and 9 component mixtures at parts-per-billion levels (7 to 10,000 ppb) in compressed gas cylinders in a balance gas of nitrogen. The criteria used for the selection of gaseous organic compounds is described. Stability studies indicate that all of the organics tested (with the exception of ethylene oxide and propylene oxide below 10 ppb levels) are stable enough to be used as reliable audit materials. Subsequent to completion of the stability studies, 202 performance audits have been initiated with the audit materials to assess the accuracy of the Volatile Organic Sampling Training and bag measurement methods during or prior to RCRA trial burn tests. Results of those audits and a summary table of the audit conducted for each POHC and the measurement system audited is described in the report. Audit results obtained with the audit bases during or prior to RCRA trial burn tests are generally within + or - 50% of the audit concentrations.

29013 (PB–90-168030/XAB) **Ambient monitoring guidelines for Prevention of Significant Deterioration (PSD).** Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. May 1987. 97p. (EPA–450/4-87/007). Available from NTIS, PC A05/MF A01.

Ambient air monitoring guidelines are described for sources that may be required to monitor the air quality under the Prevention of Significant Deterioration (PSD) regulations. Some step-by-step discussion is presented for a source to determine if monitoring will be necessary. Situations where existing air quality and meteorological data, modeling, and use of assumed background concentrations for certain areas may be used in lieu of monitoring, are shown. If a source must undertake a monitoring program, general guidance is given for pollutants to be monitored, number and location of monitoring sites, equipment, frequency and duration of sampling, and data reporting. More detailed guidance is discussed for air quality monitoring probe siting criteria for various pollutants, meteorological monitoring, and quality assurance procedures.

29014 (PB–90-168501/XAB) **Control of asbestos exposure during brake drum service.** Sheehy, J.W.; Cooper, T.C.; O'Brien, D.M.; McGlothlin, J.D.; Froehlich, P.A. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Physical Sciences and Engineering. Aug 1989. 81p. (DHHS/PUB/NIOSH–89-121). Available from NTIS, PC A05/MF A01.

Also available from Supt. of Docs.

Earlier studies of airborne asbestos exposure to mechanics during brake maintenance operations showed overexposure to asbestos fibers during brake servicing, especially brake assembly cleaning. Because an estimated 150,000 brake mechanics and garage workers in the U.S. are potentially exposed to asbestos, a known carcinogen, and the lack of information available on the effectiveness of available controls, an evaluation of these methods was initiated. Detailed field surveys were conducted at five facilities employing five methods for controlling exposure to asbestos during brake repair. These included the use of two commercial enclosure devices with ventilation provided by HEPA filter-equipped vacuum, a HEPA filter-equipped vacuum alone, a brush with recirculating cleaning solution, and cleaning solvents in aerosol cans. These controls were evaluated while servicing brakes to automobiles, pickup trucks, vans, and vehicles with a 4-wheel rear axle. Detailed evaluations of these control measures involved a program consisting of traditional air sampling methods, incorporating phase contrast microscopy (PCM) and transmission electron microscopy (TEM), and a real-time analysis of brake dust exposure. Personal and area air samples were collected during brake repair to each vehicle.

29015 (PB–90-169954/XAB) **OAQPS (Office of Air Quality Planning and Standards) control cost manual (fourth edition).** Vatavuk, W.M. Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. Jan 1990. 282p. (EPA–450/3-90/006). Available from NTIS, PC A13/MF A02.

See also PB–87-166583.

The Manual compiles up-to-date capital costs, operating and maintenance expenses, and other costs for add-on air pollution control systems and provides a comprehensive, concise, consistent, and easy-to-use procedure for estimating and (where appropriate) escalating these costs. (Add-on systems are those installed downstream of an air pollution source to control its emissions.) The Manual estimating procedure rests on the notion of the factored or study estimate, nominally accurate to within + or - 30%. This type of estimate is well suited to estimating control system costs intended for use in regulatory development. Study estimates are sufficiently accurate, yet do not require the detailed, site-specific data inputs needed to make definitive or other more accurate types of estimates.

29016 (PB–90-860875/XAB) **Ozone in the stratosphere. May 1982-January 1990 (A Bibliography from the NTIS data base).**

Report for May 1982-January 1990. National Technical Information Service, Springfield, VA (USA). Feb 1990. 127p. Available from NTISPC N01/MF N01.

Supersedes PB-88-868237.

This bibliography contains citations concerning empirical and theoretical studies and analyses of stratospheric ozone. The studies cover data collection and processing of upper atmospheric ozone concentrations. The concentrations vary with ozone transport, formation, and depletion. Data collection is performed using ground-based, airborne, and satellite-borne instrumentation and sensors. The theoretical studies include atmospheric composition, reaction kinetics, particle physics, chemical reactions, photochemistry, and atmospheric models of ozone. The investigations are based upon both the theory of photochemistry and constituents, and on analysis and comparisons of long-term measurement data. Several articles cover the Antarctic October depletion phenomenon. (This updated bibliography contains 227 citations, 55 of which are new entries to the previous edition.)

29017 (PNL-7208) **1987 wet deposition temporal and spatial patterns in North America.** Simpson, J.C.; Olsen, A.R. Pacific Northwest Lab., Richland, WA (USA). Mar 1990. 222p. Sponsored by Environmental Protection Agency. DOE Contract AC06-76RL01830. Order Number DE90010239. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

The focus of this report is on North American wet deposition temporal patterns from 1979 to 1987 and spatial patterns for 1987. The report investigates the patterns of annual precipitation-weighted average concentration and annual deposition for nine ion species: hydrogen, sulfate, nitrate, ammonium, calcium, chloride, sodium, potassium, and magnesium. Data are from the Acid Deposition System (ADS) for the statistical reporting of North American deposition data which includes the National Atmospheric Deposition Program/National Trends Network (NADP/NTN), the MAP3S precipitation chemistry network, the Utility Acid Precipitation Study Program (UAPSP), the Canadian Precipitation Monitoring Network (CAPMoN), and the daily and 4-weekly Acidic Precipitation in Ontario Study (APIOS-D and APIOS-C). Mosaic maps, based on surface estimation using kriging, display concentration and deposition spatial patterns of pH, hydrogen, sulfate, nitrate, ammonium, and calcium ion species for 1987 annual, winter, and summer periods. The temporal pattern analyses use a subset of 39 sites over a 9-year (1979–1987) period and an expanded subset of 140 sites with greater spatial coverage over a 6-year (1982–1987) period. 68 refs., 15 figs., 15 tabs.

29018 (PNL-7311) **Guidance manual on the estimation of airborne asbestos concentrations as a function of distance from a contaminated surface area for area suspension evaluations.** Stenner, R.D.; Droppo, J.G.; Peloquin, R.A.; Bienert, R.W.; VanHouten, N.C. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 102p. Sponsored by Environmental Protection Agency. DOE Contract AC06-76RL01830. Order Number DE90009627. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This Guidance Manual provides a quantitative approach for estimating the airborne concentrations of asbestos from disturbed soils and surfaces. Asbestos-containing surfaces may include roads surfaced with asbestos-bearing serpentine rock, tailings piles, and landfills. This manual identifies the procedures necessary for estimating airborne concentrations of asbestos in disturbed soils. The manual is to be used in conjunction with the Airborne Asbestos Concentration Estimator System-Area Suspension (AACES-AS) computer code. 44 refs., 16 figs., 7 tabs.

29019 (PNL-7312) **Guidance manual on the estimation of airborne asbestos concentrations as a function of distance from a contaminated roadway for roadway screening.** Stenner, R.D.; Droppo, J.G.; Peloquin, R.A.; Bienert, R.W.; VanHouten, N.C. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 57p. Sponsored by Environmental Protection Agency. DOE Contract AC06-76RL01830. Order Number DE90009626. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This Guidance Manual provides a quantitative approach for estimating, for the purpose of screening/ranking, the airborne concentrations of asbestos from roads surfaced with asbestos-bearing serpentine rock. This manual identifies the procedures necessary for estimating screening-level airborne concentrations of asbestos in disturbed soils associated with roadways whose surfacing material contains asbestos fibers. The manual is to be used in conjunction with the Airborne Asbestos Concentration Estimator System-Roadway Screening (AACES-RS) computer code. 12 refs., 11 figs., 4 tabs.

29020 (STEV-1989-R6) **Carbon dioxide from fossils combustion: Possibilities to reduce or deposite the carbon dioxide.** Dahl, A. (EnerChem AB, Lund (SE)). Statens Energiverk, Stockholm (Sweden). 12 Mar 1989. 67p. (In Swedish). Project STEV-413-801. Order Number DE90770765. Available from NTIS (US Sales Only), PC A04/MF A01.

A literature study on carbon dioxide and the greenhouse effect. The main part of the report is a review of processes for separation of carbon dioxide from the flue gases and methods to dispose of it. The cost of these processes is reported. Information is also given on methods to reduce CO_2 production in energy conversion. (With 37 refs.).

29021 (STEV-FBT-89-47) **Sampling dioxin.** Rappe, C. (Umeaa Univ., Umeaa (SE)); Marklund, S. Statens Energiverk, Stockholm (Sweden). Aug 1989. 41p. (In Swedish, English). Project STEV-276-302. Order Number DE90770791. Available from NTIS (US Sales Only), PC A03/MF A01.

A new simplified sampling method for dioxins etc. has been developed at the university of Umeaa. Comparative studies of five different sampling trains show the same results for all outfits provided a sufficient number of sampling spikes are added. (12 figs., 13 refs.).

29022 (SVF-351) **Methods of simultaneous reduction of SO_2 and NO_x.** Jantze, U. (TVE AB, Stockholm (SE)); Persson, Karin. Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden). Sep 1989. 108p. (In Swedish). Order Number DE90770843. Available from NTIS (US Sales Only), PC A06/MF A01.

This report deals with the experiences from commercial processes for simultaneous sulphur and NO_x removal, mainly based on activated coke and catalytic reduction/oxidation. The Walther and SHL processes are briefly illuminated. The first demonstration plants are now in operation. In most of the plants initial problems have occurred. After solving these troubles the plants have worked satisfactorily and guaranteed emission values have in most cases been fulfilled. Possible removal degrees for SO_2 and NO_x in catalytic reduction/oxidation processes are over 95 % and about 90 % respectively. The processes are of particular interest for plants using high sulphur fuels. This depends partly on that the operation costs decrease and partly on a better heat economy. The investment costs can be higher compared with SCR and conventional flue gas desulphurization. It is considered that lower operation costs compensate for the higher investment costs. However, the costs varies depending on application and size of the plant. Continuous development and improvements of the processes proceed. Performance and economy can be improved by more efficient catalysts and improved reactor design. Further development is expected to reduce the costs in the future. (42 figs., 4 tabs., 42 refs.).

29023 (SVF-353) **Reduction of sulfur emission through lime/limestone furnace injection.** Eklund, R.B. (Goetaverken Energy AB, Goeteborg (SE)). Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden). Oct 1989. 58p. (In Swedish). Order Number DE90770844. Available from NTIS (US Sales Only), PC A04/MF A01.

The main purpose of this project was to evaluate the efficiency of commercial available lime sources, limestone, dolomite or hydrated lime for the reduction of sulfur dioxide emission by furnace injection. All the experimental results indicate that a very fast and efficient mixing of absorbent and furnace gases is of vital importance. Experiments performed at different furnace levels indicate that furnace gas temperature has a great influence on absorption efficiency. Retention time in the furnace as well as the sulfur dioxide level of the furnace gases has little or only minor influence on the efficiency of the absorbent. The gas temperature in the furnace at the sorbent injection level has a marked influence on the absorption of sulfur dioxide. Based on calcium content of the absorbent, hydrated lime and finely ground dolomite indicate the

same efficiency at a temperature around 1000 deg C of 18 to 20 % sulfatation of the injected amount of calcium. Limestone of low geological age can reach the same efficiency, but only if ground to a very small particle size, normally not commercially available. At higher temperature level the efficiency decreases. But dolomite of small particle size indicates an efficiency of about 12.5 %, even at temperatures above 1300 deg C. Injection of lime/limestone or dolomite does not influence the NO_x content of the stack gases.

29024 (SVF–354) **Report on 1989 joint symposium on stationary combustion NO_x control.** Hjalmarsson, A.K. (Aaf Energikonsult, Stockholm (Sweden)). Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden). Oct 1989. 60p. (In Swedish). (CONF-890318–Summ.: Joint symposium on stationary combustion nitrogen oxide control, San Francisco, CA (USA), 6-9 Mar 1989). Order Number DE90770845. Available from NTIS (US Sales Only), PC A04/MF A01.

The conference, arranged by the Electrical Power Research Institute (EPRI) and US Environmental Agency (EPA) covered over 60 papers. To reduce NO_x emissions, the first measure is usually combustion control. Techniques were presented for coal-fired boilers with tangential firing systems that are expected to give emissions in the range of 100-125 mg NO_2/MJ and with reburning (MACT) 46-65 mg NO_2/MJ. For wall-fired boilers, techniques were presented that give emissions in the range of 150-350 mg NO_2/MJ. The NO_x emissions from a coal gasification plant has been measured to be in the range of 25-50 mg/MJ. Using commercial techniques for NO_x control on gas turbines a level of 50-125 mg NO_2/MJ can be reached with gas firing, and 80-250 mg NO_2/MJ for oil-firing. SCR is the most common flue gas cleaning technique. Results of 50 % NO_x reduction are reported for SNCR systems. There are a large number of SCR plants in operation in Europe. Reports were given from SCR plants that have been operating over two years that the guarantees have been met. Problems were reported from Germany with too high concentrations of ammonia in the fly ash (to use the fly ash in the cement industry) if the ammonia slip is over 5 ppm. The cost of catalysts has been reduced over the last few years in Germany and is now only one third of the cost for the first installations.

29025 (SVF–358) **Investigation of the ability of different sorbent combinations to reduce hydrochloric acid and sulphur dioxide and influence on the production of dioxines during incineration of refuse derived fuels.** Rudling, L. (Studsvik Energy, Nykoeping (Sweden)). Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden). Nov 1989. 62p. (In Swedish). Order Number DE90770842. Available from NTIS (US Sales Only), PC A04/MF A01.

In order to decrease the emission of hydrochloric acid and sulphur dioxide during incineration of refuse derived fuels, it has been investigated if a simultaneous injection of dry calcium sorbents in the furnace and after the convective part of the boiler, will give a better reduction compared to injection of sorbent only in the furnace or after the boiler. The results show that a combined injection of calcium hydroxide gave a better reduction of hydrochloric acid and sulphur dioxide, 87 % and 70 % respectively, compared to 78 and 20 % respectively when the sorbent was injected after the boiler. The total excess of calcium was the same in both cases (mole Ca/mole S+Cl/2). Concerning the production of dioxines, measured as TCDD-equivalents, the results showed that with a simultaneous injection of calcium hydroxide in the furnace and after the boiler, the production of dioxines decreased with 50 % compared to the production of dioxines without addition of any sorbent. However, the emission of dioxines in the clean gas after the electrostatic precipitator was at the same level - 2 ng TCDD-equivalents/nm^3 dry gas at 10 % CO_2 - irrespective if any sorbent was added or not. The emission of nitrogen oxides, 170 ppm NO_x and 10-20 ppm N_2O at 6 % O_2, was not influenced by any addition of sorbents. (author).

29026 (SV-UL–1989-51) **Flue gas analysis with DOAS-technique: Experiences from a test period with the Opsis measuring system.** Sjoeberg, M. Swedish State Power Board, Vaellingby (Sweden). 25 Oct 1989. 22p. (In Swedish). Order Number DE90770798. Available from NTIS (US Sales Only), PC A03/MF A01.

Emissions from fossil fueled power plants were studied using Differential Optical Absorption Spectroscopy. Nitrogen oxides and sulfur dioxide were measured and compared to results from other measuring methods and calculated values.

29027 (UCRL-CR–103232) **Computer simulation of ionospheric radio frequency heating.** Close, R. (California Univ., Los Angeles, CA (USA). Dept. of Physics); Bauer, B.S.; Wong, A.Y.; Langdon, A.B.; Kruer, W.L.; Mjoelhus, E. Lawrence Livermore National Lab., CA (USA); California Univ., Los Angeles, CA (USA). Dept. of Physics; Tromsoe Univ. (Norway). 1 Dec 1989. 34p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. ONR-N00014-78-C-0754;ONR-TPSU-UCLA-0677-387. Order Number DE90009478. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Linear and nonlinear absorption of electromagnetic waves in a warm, magnetized, nonuniform plasma is studied using an electromagnetic particle simulation code (ZOHAR) with either 1 or 2 spatial and 3 velocity dimensions. With fixed ions, finite temperature, and finite wave amplitude, transmission of the ordinary mode to the slow extraordinary wave (Z mode) is found to agree with cold plasma theory for linear conversion, and interference of mode converted waves is observed. With mobile ions and a parabolic density profile which peaks at the critical layer ($\omega_p = \omega$), the wave electric field is enhanced (factor of ten or more) near the critical layer where the wave becomes electrostatic, and small-scale density fluctuations (cavitons) are observed ($\delta\ell \approx 10\lambda_D$; $\delta n/n \approx 0.1$), typical of strong Langmuir turbulence. Wave damping and particle acceleration are also observed. Application to ionospheric heating is discussed. 15 refs., 23 figs., 1 tab.

29028 (UCRL-JC–103166) **GCM [general circulation model] predictions for surface air temperature and precipitation over the southeastern United States.** Grotch, S.L. Lawrence Livermore National Lab., CA (USA). Mar 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-900255–2: Southeast regional climate symposium: global change - a southern perspective, Charleston, SC (USA), 19-22 Feb 1990). Order Number DE90009434. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

For regional assessments of the effects of possible global climate change due to increasing greenhouse gases, two of the most significant variables predicted by general circulation models (GCMs) are surface air temperature and precipitation. In an earlier Department of Energy report, the results from four GCMs and several historical climate data sets for each of these variables (both seasonally and annually averaged) were intercompared over different regional scales using a variety of techniques. In the work reported here, several more recent, higher resolution simulations are included and attention is focused primarily on the southeastern United States. Two graphical/statistical techniques are applied: cuts intercomparing model/historical data predictions at both fixed latitudes and longitudes and side-by-side boxplots showing the quartiles of the distributions for a particular variable for a selected subset of gridpoints in a specified region. 4 refs., 11 figs.

29029 (VTT-SYMP–103, pp. 253-264) **Volatilisation and removal of trace metals at high temperatures.** Mojtahedi, W. (Technical Research Centre of Finland, Espoo (Finland). Laboratory of Fuel Processing and Lubrication Technology); Mroueh, U.-M. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. (CONF-8806445–Vol.2: Seminar on non-waste technology, Espoo (Finland), 20-23 Jun 1988). In *Non-waste technology: Volume 2.* Order Number DE90748455. Available from NTIS (US Sales Only), PC A16/MF A01.

Granular-bed filtration is investigated as an alternative to the more conventional removal systems (such as ESP and bag-filters). It is generally believed that none of these conventional devices is capable of operating at high temperatures. Moreover, a sizeable proportion of the volatilised trace metals in combustion and gasification processes will exit from the reactor in the vapour phase and these purification devices are not designned to remove the gaseous species. An inert gas such as nitrogen is heated and passed through two externally heated tubes, the first containing a metal-compound (to be investigated), volatilising some of the compound at ppm level. The gas then passes through a bed of solid

particles placed on a porous plate positioned in the second tube. The gas is sampled just above and below the second tube simultaneously for the trace metal content and analysed. The removal mechanism and efficiency is investigated under varying conditions of temperature and residence time for different solid adsorbents.

29030 (VTT-TUTK–663) **Trace elements removal from hot flue gases.** Wahab, M. (Valtion teknillinen tutkimuskeskus, Espoo (Finland). Polttoainejalostustekniikan laboratorio); Mroueh, U.M. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Nov 1989. 78p. Order Number DE90770755. Available from NTIS (US Sales Only), PC A05/MF A01.

Granular-bed filtration was investigated theoretically and experimentally with the view to its applicability to gaseous trace element removal at high temperatures. Granular-bed filters have received a great deal of attention recently as an alternative to the more conventional gas cleanup devices such as cyclones, electrostatic precipitators (ESP) and bag-filters. None of these conventional devices is capable of operating efficiently at high temperatures, (800-900 deg C), typical combined-cycle power generation plants. Moreover, a sizeable proportion of the volatilised trace metals will exit from the reactor in the vapour phase and these purification devices are not generally designed to remove the gaseous species. In an atmospheric test rig, trace elements of concern were removed in a fixed granular-bed filter at 800-900 deg C temperature range using sorbent particles (such as limestone) as the unbonded filter medium. Two configurations of the experimental apparatus were employed to enable an accurate determination of the removal efficiency of various sorbent particles. The results show that volatilised trace elements can be effectively removed from hot flue gases by passing them through a fixed bed of suitably selected solid sorbents. Removal efficiencies of higher than 99% were achieved with solid sorbent particles in the 0.3-3.0 mm size range, operating at 800-900 deg C.

29031 Alternative venting methods for residential oil heating systems. Volume 5. Batey, J.E. (Steven Winter Associates, Inc., New York, NY (US)); McDonald, R.J.; Butcher, T.A. 15p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679–: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

88-90.5.

This paper presents an overview of conventional chimney venting techniques including a review of operational problems. These include induced outdoor air infiltration into the building and undesired transient effects that can increase soot and incomplete combustion product emissions, and increase annual fuel use. Alternative venting methods are introduced and some important operational advantages are discussed. Practical concerns regarding new venting methods are briefly introduced. Research design and development activities needed to successfully apply alternative venting options are discussed.

29032 Advanced technologies for reduced CO2 emissions. Volume 5. Steinberg, M. (Brookhaven National Lab., Upton, NY (USA)); Cheng, H.C. 16p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679–: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

88-87.3.

It appears that there has been an increase in concentration of carbon monoxide in the atmosphere over the past 125 years. This has been generally attributed to the exponential growth in the use of fossil fuel resulting in the release of fossil carbon as CO2 and the deforestation or the leveling of forests around the earth which reduced the photosynthetic utilization of atmospheric CO2. This paper presents studies conducted for the Carbon Dioxide Research Division (CDRD) of the U.S. Department of Energy relating to possible mitigation technologies which would tend to reduce CO2 emissions in the future.

29033 The trade off between the complexity, input data and scale of application of the RAINS-Lake model: A statistical analysis. Volume 6. Hettelingh, J.-P. (International Institute for Applied Systems Analysis, Laxenburg, (AT)); Gardner, R.H. 16p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679–: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

88-104.1.

To use a complex, process oriented site model for predicting broad-scale environmental effects assumes the availability of a large, quality data base for calibrating the model and the validity of the process of extrapolating site-specific results to a larger region. The greater the level of extrapolation the more error prone the model results may become. A simplified version of a complex process oriented RAINS Lake Model (RLM) was developed by regression methods to quantify these extrapolation errors. RLM variables that explain more than 1% of the variation in the model output (pH of 1980) were selected and calibrated to the measured pH distribution in 1980 in the southern region of Finland from 1920 to 1980. An iterative procedure was then used to select the minimum number of variables which best represented the behavior of the RLM. The results show that extreme regional characteristics may necessitate adaptation of a simplified model that has been calibrated in a less extreme regional context.

29034 Examination of the relationship between Navajo generating station emissions and aerosol concentrations at Page, Arizona. Volume 3. Iyer, H.K. (Colorado State Univ., Fort Collins, CO (USA)); Malm, W.C. 19p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679–: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

88-52.4.

Identifying the chemical/physical characteristics and source of pollutants contributing to low lying wintertime layered hazes in the canyons along the Colorado River where it cuts through the Colorado River Plateau area is one objective of the subregional cooperative electric utility, national park service (NPS), Environmental Protection Agency (EPA) and Department of Defense (DOD) Study, (SCENES) consortium of industrial and government agencies. As part of SCENES, a short term special study, the winter haze intensive tracer experiment (WHITEX) was specially formulated to asses the feasibility of various receptor modeling techniques to attribute emissions from the Navajo Generating Station to aerosol concentrations in three National Park Service sites, Canyonlands and Grand Canyon National Parks and Glen Canyon National Recreation Area, to relate aerosol concentrations to atmospheric extinction and finally to relate extinction to visibility impairment.This paper focuses on a subset of WHITEX, the source of visibility reducing aerosols at Page (Lake Powell), Arizona.

29035 Evaluation of radon reduction techniques in fourteen basement houses: Preliminary results. Volume 6. Turk, B.H. (Lawrence Berkeley Lab., Berkeley, CA (US)); Sextro, R.G.; Harrison, J.; Hubbard, L.M.; Gadsby, K.J.; Matthews, T.G.; Dudney, C.S. 23p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679–: 81. annual meeting of Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).

Technical Paper 88-107.2.

This paper reports the preliminary results of a study of radon control techniques in 14 homes in New Jersey. The study is part of a project initiated to: investigate the fundamentals of soil gas flow and radon entry into buildings and the factors that influence the entry rate; develop a diagnostic procedure for specifying appropriate and effective remedial measures; and better understand the operation of certain mitigation techniques and the parameters that affect them. Reported is a description of the radon control work that was conducted in the houses and a summary of the results of that work.

29036 Population exposure from natural sources and consumer products. Alpen, E.L. (Univ. of California, Berkeley (USA)). pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

To set the background for a meaningful discussion of population exposure from the nuclear fuel cycle, it is necessary to examine

the competing contributors to radiation exposure for the human population. There is extensive documentation in various sources of the elements which make up the exposure of human beings to naturally occurring radiation. However, there are 3 draft documents of the National Council for Radiation Protection and Measurements which are soon to be published, and which cover, in detail, the three important aspects of this question. The three reports are those of Scientific Committee 43, Exposure to the Population in the US and Canada from natural Background; Scientific Committee 28; Radiation Exposure from Consumer Products and Miscellaneous Sources; and Scientific Committee 44, Exposure of the US Population to Diagnostic Medical Radiation. It is the purpose of this contribution to review and highlight the contacts of these documents. The dose from the first two of these sources is highly dependent upon location and other factors, but the general range of doses from natural radiation sources in the US is about 70-110 mrem/y. (0.7-1.10 mSv/y). Within recent years there has been a sharp increase in public awareness of the importance of the contribution of naturally occurring radon to exposure. Background radiation is well understood by the audience of this conference, therefore emphasis will be placed on the newer contributions relative to Quality Factor. There will be some discussion of the role of consumer products and technological enhancement of the natural contribution, as well as on the medical diagnostic exposure, which typically in advanced countries will range from 100-150 mrem/y (1.0-1.5 mSy/y). Exposure from technological enhancement and from consumer products contributes less than 10% to the total, but both are the result of human activity, and should be well understood and controlled.

29037 Current status of the NAVSEA backscatter absorption gas imaging (BAGI) development project. Kulp, T.J. (Environmental Sciences Div., Lawrence Livermore National Lab., Livermore, CA (USA)); Kennedy, R.; Garvis, D.; McRae, T. G.; Stahovec, J. pp. 307 of Laser applications in meteorology and earth and atmospheric remote sensing. Sokoloski, M.M. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). (CONF-8901157–: Laser applications in meteorology and earth and atmospheric remote sensing, Los Angeles, CA (USA), 16-18 Jan 1989).

Backscatter absorption gas imaging (BAGI) is a new technique that makes gas clouds and their surroundings visible in a real-time video image. It is superior to conventional sensors in characterizing the spatial properties of gas clouds because it provides data that are inherently two-dimensional. Less measuremental precision is required by the BAGI technique because it conveys information as contrasts between different areas in an image rather than as absolute concentration values. Furthermore, the pictorial display of this information allows it to be rapidly assimilated by emergency-response teams. The size and orientation of the plume are evident through comparison with familiar objects that also appear in the image. Subtler evaluations can be made as well, such as the distinction between innocuous and hazardous sources of the target gas. The BAGI development project is discussed in this paper. It has resulted in the creation of an instrument that is capable of imaging gases at ranges up to 30 m.

29038 Source attribution for hydrocarbons and ozone. Kleinman, L. (Brookhaven National Lab., Upton, NY (USA)); Benkovitz, C. pp. 736 of The scientific and technical issues facing post-1987 ozone control strategies. Wolff, G.T.; Hanisch, J.L.; Schere, K. Adam Hilger Ltd., Accord, MA (USA) (1988). (CONF-8711167–: APCA international specialty conference on the scientific and technical issues facing post-1987 ozone control strategies, Hartford, CT (USA), 16-19 Nov 1987).

Regional scale hydrocarbon and ozone concentrations have been calculated using a trajectory model with a linear description of hydrocarbon oxidation. The results and the model are discussed in this paper. Emitted hydrocarbons are assumed to react under the influence of an externally specified chemical environment. Emitted compounds are oxidized forming peroxy radicals which can oxidize NO, combine to form peroxides, or form adducts such as PAN. Secondary compounds can react further until complete oxidation occurs. Formation of 0_3 is associated with NO to NO_2 conversions. The linearity of the governing equations allows calculated hydrocarbon and 0_3 concentrations to be attributed to specific source regions, precursor compounds, or industrial categories. Anthropogenic and biogenic emission inventories for the contiguous U.S. are used to calculate 0_3 and hydrocarbon concentrations for a summer month.

29039 Interpretation of cloud-climate feedback as produced by 14 atmospheric general circulation models. Cess, R.D. (State Univ. of New York, Stony Brook (USA)); Potter, G.L.; Ghan, S.J.; Taylor, K.E.; Blanchet, J.P.; Boer, G.J.; Kiehl, J.T.; Slingo, A.; Washington, W.M.; Le Treut, H. *Science (Washington, D.C.) (USA)*, 245(4917): 513-516 (4 Aug 1989). DOE Contract W-7405-ENG-48.

Understanding the cause of differences among general circulation model projections of carbon dioxide-induced climatic change is a necessary step toward improving the models. An intercomparison of 14 atmospheric general circulation models, for which sea surface temperature perturbations were used as a surrogate climate change, showed that there was a roughly threefold variation in global climate sensitivity. Most of this variation is attributable to differences in the models depictions of cloud-climate feedback, a result that emphasizes the need for improvements in the treatment of clouds in these models if they are ultimately to be used as climatic predictors. 14 refs., 1 fig., 2 tabs.

29040 Organic nitrates in remote marine environments: Evidence for long range transport. Atherton, C.S. (Lawrence Livermore National Laboratory, Livermore, CA (US)). *Geophysical Research Letters (American Geophysical Union) (USA)*, 16(11): 1289-1292 (Nov 1989).

This paper examines both in-situ production and long-range transport of urban air as sources of marine alkyl nitrates. It is shown that alkyl nitrates are produced fairly rapidly in urban settings and persist for long times. The transport from urban areas can lead to alkyl nitrate concentrates of 4–83 pptv after 120–240 hours. These levels are far higher than those possible from marine in-situ production. Additionally, alkyl nitrates may be more abundant then PAN in remote marine environments. © American Geophysical Union 1989

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Refer also to citation(s) 27456, 27457, 27458, 27459, 27460, 27463, 27464, 27524, 27562, 27567, 27570, 27571, 27573, 27574, 27680, 27703, 27717, 27719, 27760, 27761, 27766, 27769, 28015, 28021, 28103, 28599, 28966, 28983, 29018, 29019, 29036, 29070, 29072, 29074, 29075, 29076, 29089, 29090, 29091, 29092, 29093, 29095, 29098, 29107, 29108, 29171, 29179, 29181, 29207, 29569

29041 (CEAC-R–4-89) **Determination of water content in natural zeolites by reflection method.** Sarria, Lopez P. (Instituto Superior de Ciencia y Tecnologia Nuclear, La Habana (Cuba)); Desdin Garcia, V.; Freixas Lemus, V.; Dominguez Ley, O.; Csikai, G. Comision de Energia Atomica, La Habana (Cuba). 1989. 6p. Order Number DE90624445. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Water content in natural zeolites collected from different site places in Cuba has been determined by neutron reflection method. Results show that it is possible to separate the minerals abundant in zeolite from the surrounding barren rocks. Water content of about 10% can be determined with 2-3% relative accuracy for different matrices, using 10 m measuring time.

29042 (CEGB-RD/B–6167/R89) **Results of a monitoring programme in the environs of Berkeley aimed at collecting Chernobyl data for foodchain model validation.** Nair, S.; Darley, P.J.; Shaer, J. Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs. Mar 1989. 28p. Order Number DE90624681. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The results of a fallout measurement programme which was carried out in the environs of Berkeley Nuclear Laboratory in the United Kingdom following the Chernobyl reactor accident in April 1986 are presented in this report. The programme was aimed at establishing a time-dependent data base of concentrations of Chernobyl fallout radionuclides in selected agricultural products. Results

were obtained for milk, grass, silage, soil and wheat over an eighteen month period from May 1986. It is intended to use the data to validate the CEGB's dynamic foodchain model, which is incorporated in the FOODWEB module of the NECTAR environmental code. (author).

29043 (CEGB-RD/B–6201/R89) **The environmental behaviour of Chernobyl deposition in a high fallout region of Sweden: analysis of the results of a soil measurement programme.** Shaer, J.; Nair, S. Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs. Apr 1989. 28p. Order Number DE90624682. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Sweden received a particularly high level of fallout from the reactor accident at Chernobyl in April 1986. An environmental monitoring programme was initiated jointly by the CEGB and Studsvik to study the behaviour of the deposited radionuclides in the rural and urban environment of Gaevle where the highest depositions were recorded. This report is concerned with the analysis of the rural data collected over the period from August 1987 to August 1988. The aim has been to develop an improved model to predict the migration of radionuclides through pasture soil. Two alternative models were developed; the first a compartment model and the second a diffusion-advection model modified to account for fixation. The predictions of the two models were tested against the results of the monitoring programme. Least squares analyses were used to establish the better of the two models and to obtain estimates of the model parameters. In all but one case, the diffusion model was found to provide the better description of the behaviour of radionuclides; the effect of advection was found to be negligible. It is intended that this model will be incorporated into an improved model to predict the uptake of activity into animal products. (author).

29044 (EMO–1007) **USATHAMA [US Army Toxic and Hazardous Materials Agency] installation restoration program research and development strategies.** White, M.K.; Fow, C.L. Pacific Northwest Lab., Richland, WA (USA). Environmental Management Operations. Mar 1990. 112p. Sponsored by U.S. Department of Defense. DOE Contract AC06-76RL01830. (CETHA-TE-CR–90002). Order Number DE90009389. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

This report is the result of a study conducted for the US Army Toxic and Hazardous Materials Agency to identify and prioritize potential research and development (R&D) activities that could reduce the cost of environmental restoration activities at Army installations where munitions production or tactical vehicle maintenance has been performed. In particular, the study examined potential R&D investments for restoration of soil and groundwater contaminated with explosives, heavy metals, and volatile organic compounds. Numerous new and innovative technologies that represent broad technology categories were considered in evaluating potential R&D investments for these restorations, and priorities for R&D investment were assigned to these technology categories. 23 refs., 16 figs., 30 tabs.

29045 (GRS–75) **Compilation of transfer factors and ecological parameters for calculation of radionuclide transport through food chains.** Biesold, H.; Handge, P. Gesellschaft fuer Reaktorsicherheit mbH (GRS), Garching (Germany, F.R.). Dec 1989. 59p. (In German). Order Number DE90773669. Available from NTIS (US Sales Only), PC A04/MF A01.

In connection with establishing the administrative guidelines 'Allgemeine Verwaltungsvorschrift zu Paragraph 45 Strahlenschutzverordnung (StrlSchV)' to be used, within the framework of the licensing procedure in the German Federal Republic for assessing exposure due to releases of radioactive materials from nuclear facilities and installations, transfer factors for soil/plant, feed/milk, and feed/meat will be summarized here as well as ecological parameters of the radioecological model appearing in the guidelines. Individual results of national and international scientific studies as well as presentations in summary were taken into account. Thereby, in particular, results of recent investigations through 1988 inclusively, and partially till 1989 were evaluated. For ecological parameters such as yield, growth time, storage time, and the crops' water and carbon content, national statistics and handbooks of agricultural practise were used. (orig.).

29046 (Juel-Spez–545) **Methods and models on soil conservation for the estimation of burdenings and for risk assessment of pollution. Status and demand on research.** Kneib, W.D.; Runge, I. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Projektleitung Biologie, Oekologie, Energie (PBE); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Dec 1989. 570p. (In German). Contract BMFT 0339186A. Order Number DE90780411. Available from NTIS (US Sales Only), PC A24/MF A01.

There are only few userfriendly applicable models to be found and even less which are able to meet the demands of a burdening and risk assessment. From the point of view of soil science many of the methods and models find a satisfactory way to treat the vertical asepct, the lateral aspect is frequently neglected though. The collected literature shows a decreasing number of models taking into account groundwater > soil solution > plant > adjacent soils. A possible way to meet all the demands of a risk assessment could be constituted by a combination of the stochastic formulation of soil data to reveal uniform areas (or standardized differences), followed by a model quantifying relative sensitivities of each area as defined within the stochastic part. All possible ways through the soil should be taken into account and the antagonistic aspects of efflux and contamination should reproducibly be represented. (orig./EF).

29047 (NAGRA-NTB–89-24) **Stripa project annual report 1988.** Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). May 1989. 127p. Available from Nagra, CH-5401 Baden, Switzerland.

The Stripa Project is an international project being performed under the sponsorship of the OECD Nuclear Energy Agency (NEA). The project concerns research related to the disposal of highly radioactive waste in crystalline rock. The Research and Development Division of the Swedish Nuclear Fuel and Waste Management Company (SKB) has been entrusted with the management of the project, under the direction of representatives from each participating country. The aim of this report is to inform the OECD Nuclear Energy Agency and the participants in the project about the general progress of work during 1988. (author) 36 figs., 5 tabs., 164 refs.

29048 (ORNL/FTR–3596) **[Preliminary work on the environmental impact statement for the US Antarctic Program]: Foreign trip report, March 17–April 11, 1990.** Railsback, S.F. Oak Ridge National Lab., TN (USA). 27 Apr 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009986. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Oak Ridge National Laboratory is preparing an environmental impact statement for the US Antarctic Program (USAP), which is operated for the National Science Foundation. This trip was a site visit to two USAP facilities: the R/V Polar Duke and Palmer Station. The Polar Duke is a 219-foot ice-strengthened vessel used as a research platform and for transportation. Palmer Station is a research base on Anvers Island near the Antarctic Peninsula. Environmental impacts include air emissions from diesel engines, discharges of untreated wastewater, the potential for spills of fuel and hazardous chemicals, and the attraction of tourists to the Palmer vicinity. Recommendations for minimizing impacts will be made in the environmental impact statement.

29049 (ORNL/TM–11470) **Colonization, road development and deforestation in the Brazilian Amazon Basin of Rondonia.** Frohn, R.C. (Oak Ridge National Lab., TN (USA)); Dale, V.H.; Jimenez, B.D. Oak Ridge National Lab., TN (USA). Mar 1990. 87p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007968. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Environmental Sciences Division Publication No. 3394.

Within the past two decades, the forests of Brazil have undergone widespread and large scale clearing. The clearing of tropical rainforests may have serious global and local consequences. Global effects include a decrease in biodiversity with the elimination of plant and animal species; increases in atmospheric carbon dioxide, which may affect climate; and disruption of hydrological

regimes. Local effects include soil erosion, siltation, decreases in soil fertility, loss of plant cover and extractive resources, and disruption of indigenous populations. Nowhere in the Brazilian Amazon has deforestation increased at a faster rate than in the state of Rondonia. Deforestation in Rondonia has grown at increasing rates during the past decade mainly because of official colonization schemes, road construction, and the subsequent settlement of farmers. This paper contains a historical summary of colonization and road construction in the Amazon Basin of Brazil relative to deforestation in Rondonia. 60 refs., 11 figs., 14 tabs.

29050 (PB–90-156225/XAB) **Technologies of delivery or recovery for the remediation of hazardous-waste sites.** Murdoch, L.; Patterson, B.; Losonsky, G.; Harrar, W. Cincinnati Univ., OH (USA). Dept. of Civil and Environmental Engineering. Jan 1990. 105p. Available from NTIS, PC A06/MF A01.

Techniques to recover contaminants or deliver treating material at contaminated sites are described in the report. Few of the 17 described delivery or recovery techniques are in use today. New technologies, used in other industries such as petroleum extraction or mining, show promise for remediation of contaminated sites, but require investigation to affirmation of their suitability for in-situ remediation. The following 17 technologies are described: Colloidal gas aphrons; Hydraulic fracturing; Radial drilling; Ultrasonic methods; Kerfing; Electro-kinetics; Jet slurrying; CO2 injection; Polymer injection; Vapor extraction; Steam stripping; Hot brine injection; In-situ combustion; Radio frequency heating; Cyclic pumping; Soil flushing; Ground freezing. Each description of a technology includes an explanation of the basic processes involved, the optimal site conditions for use, the current status of research, the personnel currently involved in research, and a list of references.

29051 (PB–90-162777/XAB) **Superfund Record of Decision (EPA Region 5): Rose Township Cemetery Dump Site, Oakland County, Michigan. (Second remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 28p. (EPA/ROD/R–05-89/110). Available from NTIS, PC A03/MF A01.

See also PB–89-133949.

The 4-acre Cemetery Dump site is a former sand and gravel pit in Rose Township, Oakland County, Michigan. During the late 1960s or early 1970s, approximately 300 to 600 drums, containing paint sludges, solvents, PCBs, and oils, were illegally dumped and buried onsite. A 1985 Record of Decision (ROD) addressed the soil cleanup which included excavation and offsite disposal of visually-contaminated soil and drum fragments. Soil which was not visually contaminated was sampled and backfilled with clean soil into the excavated areas. Subsequent soil and ground water sampling indicated that zinc contaminants in the ground water exceed the Federal secondary MCL, a nonenforceable standard based on taste and odor, not protection of health. Zinc contamination, however, is most likely a result of monitoring well construction materials. No other contaminants exceed Federal or State environmental standards.

29052 (PNL–7270) **Interim reclamation report: Basalt Waste Isolation Project exploration shaft site.** Brandt, C.A.; Rickard, W.H. Jr.; Hefty, M.G. Pacific Northwest Lab., Richland, WA (USA). Feb 1990. 46p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830. Order Number DE90009393. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In 1968, a program was started to assess the feasibility of storing Hanford Site defense waste in deep caverns constructed in basalt. This program was expanded in 1976 to include investigations of the Hanford Site as a potential location for a mined commercial nuclear waste repository. Extensive studies of the geotechnical aspects of the site were undertaken, including preparations for drilling a large diameter Exploratory Shaft. This report describes the development of the reclamation program for the Exploratory Shaft Facility, its implementation, and preliminary estimates of its success. The goal of the reclamation program is to return sites disturbed by the repository program as nearly as practicable to their original conditions using native plant species. 43 refs., 19 figs., 9 tabs.

29053 (PNL–7291) **Uncertainty in North America wet deposition isopleth maps: Effect of site selection and valid sample criteria.** Simpson, J.C.; Olsen, A.R. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 78p. Sponsored by Environmental Protection Agency. DOE Contract AC06-76RL01830. Order Number DE90008205. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report considers several issues related to the preparation of isopleth maps for the display of spatial patterns of wet deposition. The valid sample criteria and data completeness rating used in the data summarization process are described. The data interpolation technique, kriging, is presented and it's derivation in terms of generalized least squares regression is given. Four different annual summaries for pH, sulfate concentration, and sulfate deposition in 1986 are prepared using either the Unified Deposition Database Committee (UDDC) definition of valid sample criteria or a relaxed valid sample criteria and the UDDC data completeness rating or a relaxed data completeness rating. The kriged estimates for the different annual summaries and the differences between these estimates are contoured. The effects of relaxing the valid sample criteria and data completeness rating are discussed. Conclusions are drawn about network operation, network design and the uncertainty of contour maps. It is recommended that in the case where the objective is contour maps to show regional patterns, the emphasis in most regions needs to be on the number of valid samples per site and the regional representativeness of the sites. 4 refs., 14 figs., 7 tabs.

29054 **In situ treatment for contaminated soils.** Fitzpatrick, V.F. (Battelle Pacific Northwest Lab., Richland, WA (USA)). pp. 60 of Proceedings of the 1987 Pacific Northwest metals and minerals conference (abstracts): Modern mineral and metal technology. Albany Research Center, Albany, OR (USA) (1987). (CONF-8704166–: Pacific Northwest metals and minerals conference, Portland, OR (USA), 26-28 Apr 1987).

The author reports the development of a thermo-electric process for in situ treatment of contaminated soils. This process, known as in situ Vitrification (ISV), uses electrodes placed around the contaminated soil volume. This volume is then melted using the principle of joule heating. After colling, the resulting product is a vitrified mass resembling natural obsidian. Off-gases, resulting from the melting process, are contained in a hood placed over the processing area. These gases are routed to an off-gas treatment system. The process equipment is mounted in semi-trailers to facilitate transport. To minimize secondary waste, the scrub solution is recirculated. The process is independent of site services, except for electrical energy.

29055 **A comparison of environmental radionuclide concentrations calculated by a mathematical model with measured concentrations.** Jaquish, R.E. (Pacific Northwest Lab., Richland, WA (USA)); Napier, B.A. pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). DOE Contract AC06-76RL01830. (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

The Pacific Northwest Laboratory (PNL) conducts an extensive environmental monitoring program at the Hanford Site to determine radioactivity in the environment attributable to Hanford operations and to determine the resulting dose to the population. Monitoring involves the collection and analysis of environmental media including air particulates, water, soil, food crops, wildlife and vegetation. Because the environmental concentrations are so low and in most cases indistinguishable from previously deposited fallout radionuclides, the population doses are calculated using computer dose codes. The model used to calculate accumulated radiation doses from chronic ingestion of food products is incorporated in the PABLM computer code. This code estimates the transfer of radionuclides from air and irrigation water to plants and calculates the resulting concentration of radionuclides in food products. In this study, the concentrations of ^{90}Sr as calculated by PABLM were compared with measured concentrations obtained through the environmental monitoring program to determine how well the computer code predicts the environmental concentrations.

29056 Council for Health and Environmental Safety of Soils (CHESS): A coalition to standardize approaches to soil contamination problems. Kostecki, P.T.; Calabrese, E.J. pp. 515 of Petroleum contaminated soils. Volume 2. Calabrese, E.J.; Kostecki, P.T. Lewis Publishers, Chelsea, MI (USA) (1989). (CONF-8809413–: 3. national conference on the environmental and public health effects of soils contaminated with petroleum products, Amherst, MA (USA), 19-21 Sep 1988).

The organizational structure of the Council for Health and Environmental Safety (CHESS) is described in this paper. It is designed to permit peer review of relevant documents at two sequential levels. The first level of review for technical committee reports will be by the Council. A second level of review, which will incorporate not only scientific evaluation but also relevance to federal and state agencies, will be conducted by the Governing Board. In addition, both the Governing Board and Council have at their disposal the option to obtain external review from independent experts.

29057 2,3,7,8-tetrachlorodibenzo-p-dioxin: Aspects of its important properties and its potential biodegradation in soils. Arthur, M.F. (Battelle Columbus Div., OH (USA)); Frea, J.I. *Journal of Environmental Quality (USA),* 18(1): 1-11 (Jan-Mar 1989).

2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) is a persistent xenobiotic compound that has become widely dispersed in the environment. In laboratory animals, TCDD is acutely and chronically toxic, and is a carcinogen, mutagen, and teratogen. In humans, epidemiological studies of residents from Times Beach, MO, and Seveso, Italy, have failed to document significant TCDD-induced health effects. The environmental persistence of TCDD is due in part to its resistance to microbial attack. The factors responsible for microbial recalcitrance of pesticides are reviewed and related to the recalcitrance of TCDD. It is suggested that a major factor limiting TCDD degradation in the environment is its unavailability to the indigenous microflora. The possibility to decontaminate soils by mobilizing TCDD for attack by soil microorganisms is discussed.

29058 A geochemical assessment of terrestrial gamma-ray absorbed dose rates. Wollenberg, H.A. (Lawrence Berkeley Laboratory, CA (USA)); Smith, A.R. *Health Physics (USA),* 58(2): 183-189 (Feb 1990).

A survey of the geochemical literature and unpublished data has resulted in the classification of the concentrations of the naturally occurring radioelements U, Th, and K by their associated rock types. A data base of over 2500 entries has been compiled, permitting calculation of terrestrial gamma-ray absorbed dose rates. The general lithology of terrains may be distinguished by their radioelement ratios, relative abundances, and total gamma radioactivities. The gamma-ray absorbed dose rates in air above igneous rocks generally vary with their silica contents, and with the exception of shale, sedimentary rocks have lower K:U and K:Th ratios than most igneous rocks. The appreciable difference between the overall mean terrestrial gamma-ray dose rate for rock of the continental surface (approximately 7 X 10(-8) Gy h-1) and the mean dose rate from field measurements over soil (approximately 5 X 10(-8) Gy h-1) is explained by the substantial differences between radioelement concentrations of soil and rock, differences that may vary markedly with rock type.17 references.

29059 Microwave processing of radioactive materials - I. White, T.L. (Oak Ridge National Lab., TN (USA)); Berry, J.B. *American Chemical Society, Division of Environmental Chemistry, Preprints (USA),* 29(1): 127-134 (1989). DOE Contract AC05-84OR21400. (CONF-8904177–: Symposium on innovative waste management technologies, Dallas, TX (USA), 9-14 Apr 1989).

This report reviews the applications of microwave energy for processing radioactive materials with particular emphasis on processing radioactive wastes. The focus will be on the two FCC-approved microwave frequencies for industrial, scientific, and medical use, 915 and 2450 MHz. Five advantages of microwave heating over conventional heating is presented. Special design issues unique to microwave plants are discussed. Four applications of microwave power to processing of radioactive materials is presented.

29060 Patterns of leaf and flower removal: Their effect on fruit growth in Chamaenerion angustifolium (fireweed). Shea, M.M. (Indiana Univ., Bloomington (USA)); Watson, M.A. *American Journal of Botany (USA),* 76(6): 884-890 (Jun 1989). DOE Contract AC09-76SR00819.

The response of Chamaenerion angustifolium (fireweed) plants of different patterns of artificial leaf and flower herbivory was examined to determine if the effects of localized herbivory were confined within vertical sectors of the plant. The effect of leaf and flower removal on fruit development was compared for removals within sectors and distributed among sectors. Fruit development did not differ in plants subjected to different patterns of leaf and flower removal. These results suggest that in disturbed plants carbohydrate movement is not confined within vertical sectors.

29061 Macroecology: The division of food and space among species on continents. Brown, J.H. (Univ. of New Mexico, Albuquerque (USA)); Maurer, B.A. *Science (Washington, D.C.) (USA),* 243(4895): 1145-1150 (3 Mar 1989).

Analyses of statistical distributions of body mass, population density, and size and shape of geographic range offer insights into the empirical patterns and causal mechanisms that characterize the allocation of food and space among the diverse species in continental biotas. These analyses also provide evidence of the processes that couple ecological phenomena that occur on disparate spatial and temporal scales - from the activities of individual organisms within local populations to the dynamics of continent-wide speciation, colonization, and extinction events. 26 refs., 6 figs.

29062 Temperature, water availability, and nutrient levels at various soil depths-consequences for shallow-rooted desert succulents, including nurse plant effects. Nobel, P.S. (Univ. of California, Los Angeles (USA)). *American Journal of Botany (USA),* 76(10): 1486-1492 (Oct 1989).

Soil conditions were evaluated over the rooting depths for Agave deserti and Ferocactus acanthodes from the northwestern Sonoran Desert. These succulents have mean root depths of only 10 cm when adults and even shallower distribution when seedlings, which often occur is association with the nurse plant Hilaria rigida, which also has shallow roots. Maximum soil temperatures in the 2 cm beneath bare ground were predicted to exceed 65 C, which is lethal to the roots of A. deserti and F. acanthodes, whereas H. rigida reduced the maximum surface temperatures by over 10 C, providing a microhabitat suitable for seedling establishment. Water Availability was defined as the soil-to-plant drop in water potential, for periods when the plants could take up water, integrated over time. Below 4 cm under bare ground, simulated Water Availability increased slightly with depth (to 35 cm) for a wet year, was fairly constant for an average year, and decreased for a dry year, indicating that the shallow rooting habit is more advantageous in drier years. Water uptake by H. rigida substantially reduced Water Availability for seedlings associated with this nurse plant. On the other hand, a 66-90% higher soil nitrogen level occurred under H. rigida, possibly representing its harvesting of this macronutrient from a wide ground area. Phosphorus was slightly less abundant in the soil under H. rigida compared with under bare ground, the potassium level was substantially higher, and the sodium level was substantially lower. All four elements varied greatly with depth, N and K decreasing and P and Na increasing. Based on the known growth responses of A. deserti and F. acanthodes to these four elements, growth was predicted to be higher for plants in soil from the shallower layers, most of the differences being due to nitrogen.

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Refer also to citation(s) 27463, 27464, 27465, 27562, 27567, 27568, 27569, 27571, 27573, 27677, 27680, 27685, 27712, 27713, 27714, 27715, 27716, 27732, 27737, 27745, 27764, 27769, 27845, 27846, 27948, 28012, 28021, 28103, 28145, 28928, 28966, 28983, 29036, 29044, 29048, 29050, 29051, 29055, 29147, 29173

29063 (AD-A–216501/7/XAB) **Measuring the effectiveness of nonpoint-source control techniques for aquatic protection. Final summary report.** Gadbois, L.E. Naval Ocean Systems Center, San Diego, CA (USA). Nov 1989. 15p. (NOSC/TD–1682). Available from NTIS, PC A03/MF A01.

Documenting the effectiveness of nonpoint source (NPS) pollution control technologies requires a technique- and a site-specific monitoring program. This report details an evaluation method developed to determine which NPS control technique should be used, and how to evaluate the control's effectiveness. Attention to nonpoint source pollution (NPSP) originating from stormwater runoff is growing as point sources are eliminated or controlled. NPSP has largely escaped regulation because of frequent difficulty in identifying a culpable source and quantifying its environmental impact, as well as from little knowledge of effective control techniques. The lack of corporate knowledge of NPSP control techniques results from limited historical regulation and from poorly developed methods to measure the techniques' effectiveness. The refinement of a single or small set of control techniques will not be appropriate for all NPSP due to the diversity of pollutants in runoff. Several measures of effectiveness may be needed for each technique due to site-specific variations.

29064 (AD-A-216502/5/XAB) **Evaluation of four well-casing materials for monitoring selected trace-level organics in ground water.** Cold Regions Research and Engineering Lab., Hanover, NH (USA). Oct 1988. 37p. Available from NTIS, PC A03/MF A01.

In this study we examined four well casing materials, polyvinyl chloride (PVC), teflon, stainless steel 304 (SS 304) and stainless steel 316 (SS 316), to determine their suitability for monitoring selected trace level organic constituents in ground water. Analyte solutions containing pieces of the different well casings were compared to controls that did not contain well casing material. The aqueous test solution contained approximately 2 mg/l of each of the following organic substances: hexahydro-1,3,5-triazine (RDX), trinitrobenzene (TNB), cis- and trans-1,2-dichlorobenzene(CDCE and TDCE), m-Nitrotoluene(MNT), trichloroethylene(TCE), chlorobenzene(CLB), and o-, p-, and m-dichlorobenzene(ODCB, PDCB, and MDCB). Mercuric chloride was added to prevent biodegradation of the analytes. The two sets of isomers for DCE and DCB were selected to examine the effect of structure on sorption. Samples were taken after 0 hour, 1 hour, 8 hours, 24 hours, 72 hours, 7 days (168 hours), and approximately 6 weeks (1000 hours). There was no loss of any analyte in the samples that contained either type of stainless steel casing, although both types of casing rusted. The greatest losses were seen in samples that contained teflon casings, especially for the chlorinated organics. Losses of PDCB and MDCB were the greatest, 16% and 18%, respectively, after only 8 hours. While losses were also observed for the samples containing PVC casing, the rate ofloss was much slower, and usually 24 hours or more elapsed before losses were significant (more than 5%). After the 1000-hour samples were taken, the casings were rinsed and placed in clean vials containing fresh water and left for three days to allow for desorption.

29065 (CONF-9004173-1) **DUVAS [derivative ultraviolet absorption spectrometry] fiberscope for in situ groundwater monitoring.** Haas, J.W. III; Gammage, R.B. Oak Ridge National Lab., TN (USA). [1990]. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From DOE real-time subsurface monitoring of groundwater workshop; Dallas, TX (USA); 17-18 Apr 1990. Order Number DE90009822. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper discusses the Department of Energy (DOE) Real-Time Subsurface Monitoring Workshop held in Dallas, Texas. The project objective is to develop a rapid and reliable method for measuring the spatial and temporal distribution of organic solvents and fuel contaminants in groundwater on the Oak Ridge Reservation. One strategy for meeting this need is development of in situ sensors which respond to specific contaminants or classes of contaminants. Because of its proven ability to detect compounds such as benzene and its derivatives, which are common solvents and components of fuels, derivative ultraviolet absorption spectrometry (DUVAS) is being developed for in situ detection of aromatic pollutants. A prototype DUVAS fiberscope has been constructed and tested for groundwater analysis. An important component of the fiberscope is a rugged, down-well prove with a unique "detector-in-head" design that increases the maximum depth of subsurface detection. Results comparable to those obtained with a conventional laboratory spectrometer have been achieved with optical fiber lengths up to 50 meters. 9 figs., 2 tabs.

29066 (DOE/BP/63406-3) **Climate change in the Pacific Northwest and its impact on energy planning: Preliminary report on findings: Final report.** Wade, J.E.; Wittrup, R.; Redmond, K.; Buckley, J. Oregon State Univ., Corvallis, OR (USA). Wind Resources Assessment Lab. Sep 1987. 79p. Sponsored by U.S. DOE Management & Administration. DOE Contract BI79-86BP63406. (BPA-87-26). Order Number DE90009462. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report is a summary of the FY 87 research on energy related climatic variation. The report will discuss the findings, their implications and suggest profitable areas of research. Examination of climate variation is particularly timely consideration given the recent drought in the Pacific Northwest. This report describes a number of interesting trends, cyclic variations and inter-relationships that could be useful in energy planning. Topics include wind drought, recent snowpack variations, precipitation trends, temperature trends and future climate research. 37 refs., 51 figs., 3 tabs.

29067 (GKSS-89/E/32) **A study on the transport of pollutants through the Hamburg harbour.** Fanger, H.U. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik); Kolb, M.; Michaelis, W.; Mueller, A.; Schoenburg, M. GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). 1989. 8p. Available from GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.).

In September 1986, a comprehensive measuring campaign in the Elbe bifurcation area of Hamburg was conducted by GKSS. Hydrographic measuring techniques including the moving boat method, sophisticated trace analytical procedures, and fluorescent dye (Rhodamine-B) tracer techniques were applied. Over more than six coherent tidal cycles, a consistent set of data on discharges of water, suspended matter, particulate and dissolved trace elements (heavy metals) has been obtained for cross-sections at the harbour entrance Oortkaten and the harbour exit Nienstedten. Transport and residence times of river water and its dissolved constituents (e.g. Ni, As, Sb) resulted from analysis of space/time dependent Rhodamine concentrations. From stratigraphic trace-analyses of Harburg harbour sediments, performed in an separate study on behalf of the Ministry of Environment, Hamburg, it has been concluded that the increase in heavy metal concentration started before the turn of the century. (orig.).

29068 (GKSS-89/E/38) **Investigations of the resuspension behaviour of estuarine suspended matter.** Noether, B. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik). GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.); Fachhochschule Hamburg (Germany, F.R.). 1989. 97p. (In German). Order Number DE90780174. Available from NTIS (US Sales Only), PC A05/MF A01.

Laboratory experiments were carried out to examine the critical shear stress and the resuspension behaviour of freshly deposited estuarine suspended matter. The experimental parameters were the bed thickness, the time of deposition and the acceleration of flow velocity. Flocs of suspended matter were produced in a 5 m high settling tube by mild turbulence. During simulated slack water periods of 1 and 2 hours, the flocs were allowed to deposit and to form a bed. That bed was resuspended by a propeller in fixed shear stress intervals, simulating the increase of flow velocity after slack water. The same value of the critical shear stress was found for all experiments, independent of the experimental parameters. The only significant parameter for resuspension behaviour was the bed thickness. (orig.) With 27 figs., 21 tabs.

29069 (GKSS-89/E/48) **Modeling of the brackish water dynamics of the lower Elbe estuary.** Duwe, K. (GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik). GKSS-Forschungszentrum Geesthacht GmbH, Geesthacht-Tesperhude (Germany, F.R.); Hamburg Univ. (Germany, F.R.). Fachbereich Geowissenschaften.

1989. 194p. (In German). Order Number DE90780377. Available from NTIS (US Sales Only), PC A09/MF A01.

By means of three-dimensional baroclinic numerical models and detailed observational data specific dynamical processes of the brackish water zone of tidal estuaries are being investigated. The author looks especially at the Lower Elbe estuary where many measurements data and observations were at hand. The developed model formulations were used in high resolving, three-dimensional, baroclinic current models to investigate the current and mass field in the whole brackish water zone as well as in a special section of the wadden sea area around the tidal creek Neuenfelder Rinne. It is concluded that in questions of transport processes and their associated current fields the influence of the variable salinity is of considerable importance. (orig.) With 87 figs., 11 tabs.

29070 (ORNL–6602) **Environmental Sciences Division annual progress report for period ending September 30, 1989.** Oak Ridge National Lab., TN (USA). Apr 1990. 267p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007969. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

Environmental Sciences Division Publication No. 3400.

This progress report summarizes the research and development activities conducted in the Environmental Sciences Division of Oak Ridge National Laboratory during the period October 1, 1988, through September 30, 1989. The report is structured to provide descriptions of current activities and accomplishments in each of the division's major organizational units. Following the sections describing the organizational units is a section devoted to lists of information necessary to convey the scope of the work in the division.

29071 (ORNL/TM–11368) **Groundwater parameters and flow systems near Oak Ridge National Laboratory.** Moore, G.K. (Tennessee Univ., Knoxville, TN (USA)). Oak Ridge National Lab., TN (USA). Sep 1989. 83p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010210. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Environmental Sciences Division Publication No. 3403.

This report is intended to supplement a recent study that revised the concepts of groundwater occurrence and flow in the Oak Ridge National Laboratory (ORNL) area. Some new data have been acquired, but the present report, for the most part, consists of a further interpretation of previously available data. Several additional factors and processes that may affect the groundwater budget of the ORNL area are described. Also, some parameter values in the previous report were based on relatively few data; the present report used convergence of evidence to test these values. Finally, the additional interpretations in the present report revise some of the parameter values in the previous report. The purposes of the present report are to derive more accurate parameter values for future digital modeling and to better characterize the various groundwater flow systems. The resulting conceptual model should be applicable to other areas on the Oak Ridge Reservation and to many other areas underlain by consolidated rocks. 32 refs., 14 figs., 1 tab.

29072 (PB–90-150962/XAB) **Superfund Record of Decision (EPA Region 2): Ewan Property, NJ. (Second Remedial Action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 121p. (EPA/ROD/R–02-89/095). Available from NTIS, PC A06/MF A01.

See also PB–89-196760.

The 43-acre Ewan Property site is in the New Jersey Pinelands in Shamong Township, Burlington County, New Jersey. Between 1974 and 1975 the site owner reportedly buried uncontained and drummed hazardous wastes in an onsite disposal area. In 1982 the county was informed of the possible hazardous waste dumping and initiated ground water monitoring and soil sampling programs the following year. Both the ground water and soil within the disposal area were found to be contaminated with VOCs and metals. The remedial action represents the second of two operable units for the site. The 1988 Record of Decision addressed the treatment of 4,500 cubic yards of source waste including buried drums and other heavily contaminated materials. The second operable unit addresses the remediation of the residual soil which will remain after implementation of the first operable unit and the treatment of the contaminated ground water. The primary contaminants of concern affecting the soil and ground water are VOCs including benzene, PCE, TCE, toluene, and xylenes; and metals including chromium and lead.

29073 (PB–90-153511/XAB) **Proximity of Pennsylvania sanitary landfills to wetlands and deepwater habitats: Statewide results.** Herndon, R.C.; Moerlins, J.E.; Lambou, V.W.; Gebhard, R.L. Florida State Dept. of Education, Tallahassee, FL (USA). Universities Div. Dec 1989. 33p. Available from NTIS, PC A03/MF A01.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. The purpose of the report is to document the proximity of sanitary landfills included in the study in Pennsylvania to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.). The sanitary landfills were identified on U.S. Fish and Wildlife Service's National Wetlands Inventory maps. The nearness or proximity of the sanitary landfills to wetlands and deepwater habitats was determined by drawing three concentric regions around the point representing the location of each landfill. The radii of the concentric regions were: 1/4 mile, 1/2 mile, and 1 mile. A companion report summarizes the statewide results. The data on individual landfills include: (1) general facility/site data, and (2) wetlands/deepwater habitat data.

29074 (PB–90-153701/XAB) **Superfund Record of Decision (EPA Region 2): Chemical Insecticide, Middlesex County, NJ. (First Remedial Action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 81p. (EPA/ROD/R–02-89/098). Available from NTIS, PC A05/MF A01.

Portions of this document are not fully legible.

The Chemical Insecticide site is part of a 94-acre industrial development in Edison, Middlesex County, New Jersey. From 1958 to 1970 Chemical Insecticide Corporation (CIC) produced and stored pesticide formulations at the property resulting in soil, surface water, and ground water contamination. Between 1966 and 1969 CIC was ordered by the city to close onsite lagoons, dispose of leaking drums, and stop wastewater discharge. Subsequent RI/FS investigations revealed the extreme complexity of the site due to the number and variety of contaminants (herbicides, pesticides, and metals) and the physical characteristics of the site. The primary contaminants of concern in the soil which may affect the surface water are organics including pesticides, and metals including arsenic. The selected remedial action for this site includes clearing and grading the site; covering the entire site with an impermeable surficial cap; constructing a surface water runoff diversion system; controlling the release of collected, uncontaminated surface water runoff from the site; and surface water monitoring.

29075 (PB–90-153727/XAB) **Superfund Record of Decision (EPA Region 2): Port Washington Landfill, Nassau County, NY. (First Remedial Action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 30 Sep 1989. 137p. (EPA/ROD/R–02-89/082). Available from NTIS, PC A07/MF A01.

Portions of this document are not fully legible.

The Port Washington Landfill site is on the eastern portion of Manhasset Neck, Nassau County, Long Island, New York. The 139-acre municipally owned site consists of two landfilled areas separated by a vacant area. The Record of Decision addresses the 53-acre inactive landfill on the western portion of the site, which is the suspected source of methane gas thought to cause furnace explosions in residences neighboring the landfill during 1979 through 1981. From 1974 to 1983 the landfill operator accepted incinerator residue, residential and commercial refuse, and construction rubble for disposal. Because extensive air monitoring, performed in 1981, revealed high methane levels in several areas residences, a venting system was installed to prevent subsurface gases from migrating west of the landfill and to destroy hazardous chemicals commonly detected in sanitary landfill gas. The selected remedial action for the site includes capping the landfill; rehabilitating the

existing gas collection system and installing additional vacuum extraction vents; ground water pumping and treatment.

29076 (PB–90-153768/XAB) **Superfund Record of Decision (EPA Region 1): Kellogg-Deering Well Field, Norwalk, CT. (Second Remedial Action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 128p. (EPA/ROD/R–01-89/039). Available from NTIS, PC A07/MF A01.

See also PB–87-189866.

The Kellogg-Deering Well Field site is a 10-acre contaminated municipal well field in Norwalk, Fairfield County, Connecticut, which includes adjacent source areas that contribute to the well field contamination. The city detected elevated TCE levels in the wells during routine monitoring in 1975 and subsequently shut down unacceptably contaminated wells until a redwood slat treatment system was installed in 1981. EPA conducted a remedial investigation between 1984 and 1986 leading to a 1986 Record of Decision (ROD) which required the city to operate an air stripping unit. EPA conducted a subsequent remedial investigation in 1987 which further defined the contaminated ground water area. The primary contaminants of concern affecting the soil and ground water are VOCs including benzene, PCE, TCE, toluene, and xylenes.

29077 (PB–90-155623/XAB) **Proximity of Connecticut sanitary landfills to wetlands and deepwater habitats: Statewide results.** Lambou, V.W.; Herndon, R.C.; Moerlins, J.E.; Gebhard, R.L. Florida State Univ., Tallahassee, FL (USA). Center for Biomedical and Toxicological Research and Hazardous Waste Management. Nov 1989. 33p. Available from NTIS, PC A03/MF A01.

See also PB–90-155631.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. The purpose of the reports are to summarize the proximity of sanitary landfills in Connecticut to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.) and present data on the individual landfills. The sanitary landfills were identified on U.S. Fish and Wildlife Service's National Wetlands Inventory maps. Most sanitary landfills in Connecticut are located in or are close to either wetlands or deepwater habitats. These facilities have the potential to adversely affect sensitive ecosystems, such as wetlands and deepwater habitats, either through habitat alterations or through the migration of contaminants from sanitary landfills.

29078 (PB–90-155631/XAB) **Proximity of Connecticut sanitary landfills to wetlands and deepwater habitats: Data on individual landfills.** Lambou, V.W.; Herndon, R.C.; Moerlins, J.E.; Bebhard, R.L. Florida State Univ., Tallahassee, FL (USA). Center for Biomedical and Toxicological Research and Hazardous Waste Management. Nov 1989. 29p. Available from NTIS, PC A03/MF A01.

See also PB–90-155623.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. The purpose of the report is to document the proximity of sanitary landfills included in the study in Connecticut to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.). The sanitary landfills were identified on U.S. Fish and Wildlife Service's National Wetlands Inventory maps. A companion report summarizes the statewide results. These facilities have the potential to adversely affect sensitive ecosystems, such as wetlands and deepwater habitats, either through habitat alterations or through the migration of contaminants from sanitary landfills.

29079 (PB–90-155649/XAB) **Proximity of New York sanitary landfills to wetlands and deepwater habitats: Statewide results.** Moerlins, J.E.; Herndon, R.C.; Lambou, V.W.; Gebhard, R.L. Florida State Univ., Tallahassee, FL (USA). Center for Biomedical and Toxicological Research and Hazardous Waste Management. Dec 1989. 33p. Available from NTIS, PC A03/MF A01.

See also PB–90-155656.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. The purpose of the reports are to summarize the proximity of sanitary landfills in New York to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.) and present data on the individual landfills. The sanitary landfills were identified on U.S. Fish and Wildlife Service's National Wetlands Inventory maps. The nearness or proximity of the sanitary landfills to wetlands and deepwater habitats was determined by drawing three concentric regions around the point representing the location of each landfill. These facilities have the potential to adversely affect sensitive ecosystems, such as wetlands and deepwater habitats, either through habitat alterations or through the migration of contaminants from sanitary landfills.

29080 (PB–90-155656/XAB) **Proximity of New York sanitary landfills to wetlands and deepwater habitats: Data on individual landfills.** Moerlins, J.E.; Herndon, R.C.; Lambou, V.W.; Gebhard, R.L. Florida State Univ., Tallahassee, FL (USA). Center for Biomedical and Toxicological Research and Hazardous Waste Management. Dec 1989. 59p. Available from NTIS, PC A04/MF A01.

See also PB–90-155649.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. The purpose of the report is to document the proximity of sanitary landfills included in the study in New York to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.). The sanitary landfills were identified on U.S. Fish and Wildlife Service's National Wetlands Inventory maps. The nearness or proximity of the sanitary landfills to wetlands and deepwater habitats was determined by drawing three concentric regions around the point representing the location of each landfill. A companion report summarizes the statewide results. These facilities have the potential to adversely affect sensitive ecosystems, such as wetlands and deepwater habitats, either through habitat alterations or through the migration of contaminants from sanitary landfills.

29081 (PB–90-157504/XAB) **Assessment of episodic acidification in the Sierra Nevada, California. Final report, 1987-1989.** Schnoor, J.L.; Nikolaidis, N.P.; Nikolaidis, V.S. Department of Energy, Washington, DC (USA). Div. of Conservation Research and Technology. Aug 1989. 69p. Available from NTIS, PC A04/MF A01.

Researchers compiled data on 168 low-ANC lakes in the Sierra Nevada, California. They then formulated an Episodic Event Model (EEM) that was used to simulate lake ANC during snowmelt episodes. During snowmelt the surface water ANC is near zero due to dilution from snowmelt. During this period acidification can occur should acidic rain enter the watershed. Using the EEM to simulate a 20-day runoff event at snowmelt, the model results indicate that about 80% of the lakes considered would reach an ANC less than 40 micro eq/l. There are insufficient spatial or temporal data on the chemistry or amount of deposition to high-elevation areas in the Sierra. Also, the model assumes no interaction between the watershed and incoming deposition.

29082 (PB–90-159393/XAB) **Assessing the relationship between Section 404 and wetland losses: A feasibility study.** Roelle, J.E.; Asherin, D.A.; Gladwin, D.N. National Ecology Research Center, Fort Collins, CO (USA). Sep 1989. 25p. (BIOLOGICAL–89(21)). Available from NTIS, PC A03/MF A01.

Also available from Supt. of Docs.

The primary objective of the Clean Water Act of 1977 (33 U.S.C. 1251) is to restore and maintain the physical, chemical, and biological integrity of the Nation's waters. Section 404 of the Act regulates the discharge of dredged or fill materials into wetlands and represents the primary Federal authority for regulation of wetland alterations. Since its inception, the Section 404 program has been controversial in regard to the extent to which it was intended to provide wetlands regulation. The U.S. Army Corps of Engineers (Corps) issues Section 404 permits, which can be of two types. Individual Permits are issued following case-by-case reviews of proposed discharges. General Permits, which can be either nationwide or regional in scope are authorized by the Corps for categories of activities that are similar in nature and that have only minimal individual and cumulative adverse environmental impacts. At present, 26 categories of Nationwide Permits have been authorized by the Corps.

29083 (PB–90-159807/XAB) **Handbook of suggested practices for the design and installation of ground-water monitoring wells. Final report, June 1985-July 1989.** Aller, L.; Bennett, T.W.; Hackett, G.; Denne, J.E.; Petty, R.J. Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring Systems Lab. Feb 1990. 416p. (EPA–600/4-89/034). Available from NTIS, PC A18/MF A03.

The document is intended to assist personnel involved with the design, construction, and installation of ground-water monitoring wells. It does not focus on specific regulatory requirements, but instead presents state-of-the-art technology that may be applied in diverse hydrogeologic situations. The Handbook addresses field-oriented practices to solve monitoring well construction problems rather than conceptual or idealized practices. The information is presented in both matrix and text form. The matrices use a relative numerical rating scheme to guide the user toward appropriate drilling technologies for particular monitoring situations. The text provides the narrative overview of the criteria that influence groundwater monitoring well design and construction. Such influencing factors include purpose, location, site hydrogeology, contaminant characteristics, anthropogenic activities, and testing equipment.

29084 (PB–90-160722/XAB) **Chemical and toxicological analyses of Lake Calumet (Cook County, Illinois) sediments.** Ross, P.E.; Burnett, L.C.; Henebry, M.S. Illinois Inst. of Natural Resources, Champaign, IL (USA). Illinois Natural History Survey. Sep 1989. 79p. Available from NTIS, PC A05/MF A01.

Lake Calumet, located on Chicago's Far South Side, has been exposed to a wide range of industrial contaminants for approximately 110 years. Continued industrial activity and residues from past waste disposal practices, however, still threaten the Lake Calumet system. A study was initiated in 1986 by the Hazardous Waste Research and Information Center (HWRIC) of the Illinois Department of Energy and Natural Resources to Make a preliminary assessment of the physical, chemical, and biological processes that influence the environmental quality of Lake Calumet and the surrounding area and to predict the ecological effects of the contamination associated with lake sediments.

29085 (PB–90-160771/XAB) **Activity of PCBs (polychlorinated biphenyls) in sediments and water from Lake Calumet and Waukegan Harbor.** Murphy, T.J.; Galinis, D.L.; Arnold, C. DePaul Univ., Chicago, IL (USA). Dept. of Chemistry. Dec 1989. 55p. Available from NTIS, PC A04/MF A01.

Techniques were developed to measure the activity (fugacity; escaping tendency) of semi-volatile organic compounds, PCBs in this case, in water and sediment samples. The techniques were applied to samples from Lake Calumet and Waukegan Harbor. Knowing the activities of the PCBs in the samples permitted the following to be determined: (1) the thermodynamic sediment/water partition coefficient, Kd; (2) the direction of movement of compounds between the sediments and water; (3) the expected PCB concentrations in the water at equilibrium with the sediments; (4) the amount of PCBs evaporating per year from these bodies of water; and (5) an average partition coefficient for the PCBs present in each sediment sample, Kd.

29086 (PB–90-160961/XAB) **Effectiveness of the innovative and alternative waste-water-treatment technology program. Report to the Congress.** Environmental Protection Agency, Washington, DC (USA). Office of the Assistant Administrator for Water. Sep 1989. 170p. (EPA–430/09-89/009). Available from NTIS, PC A08/MF A01.

The Report to Congress, required by Section 517 of the Water Quality Act of 1987, Public Law No. 100-4, presents the results of an Environmental Protection Agency study of the effectiveness of the innovative and alternative (I/A) wastewater treatment technology program. The objectives of the study are to summarize information by State on the types of I/A wastewater treatment technologies and on the number of facilities constructed employing them, describe I/A technologies that have not performed to design standards, determine which States have not obligated the set-aside for I/A technologies and the reasons for failure to make such obligations, and recommend more effective incentives for using I/A wastewater treatment technologies.

29087 (PB–90-160995/XAB) **Multispectral identification and confirmation of organic compounds in waste-water extracts.** McGuire, J.M.; Collette, T.W.; Thurston, A.D.; Richardson, S.D.; Payne, W.D. Environmental Protection Agency, Athens, GA (USA). Environmental Research Lab. Feb 1990. 204p. (EPA–600/4-90/002). Available from NTIS, PC A10/MF A02.

Application of multispectral identification techniques to samples from industrial and POTW wastewaters revealed identities of 63 compounds that had not been identified by empirical matching of mass spectra with spectral libraries. Twenty-five of the compounds had not been found in wastewaters previously. Multispectral techniques used in the identifications were GC/MS (low resolution), high resolution mass spectrometry, positive methane chemical ionization mass spectrometry, and gas chromatography combined with Fourier transform infrared spectroscopy. Some of the same techniques were used to confirm (without obtaining a pure sample of the tentatively identified compound) identifications made by reexamination of GC/MS data tapes generated by contractor laboratories. Eighty percent of the identifications were confirmed. Some of the wrong identifications made by reexamination of the tapes were attributed to poor chromatography during the initial analysis.

29088 (PB–90-162231/XAB) **Evaluation of stream liming effects on water quality and spawning of migratory fishes in Maryland Coastal Plain streams. 1988 results. Final report.** Greening, H.S.; Janicki, A.J.; Klauda, R.J.; Baudler, D.M.; Levin, D.M. International Science and Technology, Inc., Sterling, VA (USA). Sep 1989. 244p. Available from NTIS, PC A11/MF A02.

See also PB–89-132294.

Calcite dosers were tested in 1988 on three Maryland Coastal Plain streams subject to acidic pulses during precipitation events. Increased flow during precipitation events resulted in depressed pH, ANC and Ca concentrations and elevated A1 levels in untreated sections of each study stream. Water quality in areas of each stream receiving calcite slurry was maintained near baseflow conditions. In situ survival tests were performed on yellow perch and blueback herring. Adult spawning surveys, ichthyoplankton collections, and juvenile surveys showed several migratory fish populations to be near historically low levels in four of the five streams sampled in 1988.

29089 (PB–90-162611/XAB) **Superfund Record of Decision (EPA Region 7): Chemplex, Clinton, IA. (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 27 Sep 1989. 84p. (EPA/ROD/R–07-89/024). Available from NTIS, PC A05/MF A01.

The Chemplex site is in Clinton County within 5 miles of Clinton, Iowa, and includes a landfill, a waste water treatment plant, and an adjacent facility which manufactures high and low density polyethylene. From 1968 to 1978 the landfill area was used for disposal of various plant wastes including black oily sludge, scrap polyethylene, construction debris, and carbonate sludge. The debutanized aromatic concentrate (DAC) area, which consists of a pit and DAC product storage and loading areas, was contaminated by DAC spillage. In 1987, waste was reportedly removed from the pit and disposed of in a RCRA permitted landfill. Wastes and spills have contaminated the soil and ground water underneath the landfill and DAC areas. This first operable unit will address the plumes of ground water contamination. A subsequent operable unit remedy for the site will address the cleanup of soil and other ground water remediation that may be required. The primary contaminants of concern affecting the ground water are VOCs including benzene, toluene, xylenes, TCE, and PCE; and other organics including carcinogenic and noncarcinogenic PAHs.

29090 (PB–90-162645/XAB) **Superfund Record of Decision (EPA Region 7): Doepke Disposal (Holliday), KS. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 21 Sep 1989. 84p. (EPA/ROD/R–07-89/032). Available from NTIS, PC A05/MF A01.

The Doepke Disposal (Holliday) site is an inactive industrial-waste landfill located east of Holliday, Johnson County, Kansas. During the 1950s and early 1960s the site was used as a landfill for residential refuse. In 1963 Doepke Disposal Service, Inc.

leased the property and operated a commercial and industrial waste landfill until 1970, when the State shut down the operation. Materials such as fiberglass, fiberglass resins, paint sludges, spent solvents, metal sludges, soaps, and pesticides were reportedly disposed of at the landfill. In 1966 fire debris and up to 374 drums of solvents and organochlorine and organophosphate pesticides were disposed of at the site as a result of a fire at a Kansas City chemical plant. Initially wastes and residues brought to the site were burned, however, in the late 1960s burning operations ceased and solid wastes were buried onsite and liquids were disposed of in two surface impoundments. In 1977 rock material excavated during the construction of an interstate was dumped onsite and in some cases over the deposited waste. The current owner uses portions of the site for storage of clay, crushed shales, and crushed limestone. The primary contaminants of concern affecting the soil and ground water are VOCs including benzene, toluene, and xylene; other organics including PAHs, PCBs, and pesticides, and metals including chromium and lead.

29091 (PB–90-162678/XAB) **Superfund Record of Decision (EPA Region 3): Cryochem, Berks County, PA (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 89p. (EPA/ROD/R–03-89/078). Available from NTIS, PC A05/MF A01.

Portions of this document are not fully legible.

The 19-acre CryoChem facility is a metal fabricating facility in the village of Worman, Earl Township, Berks County, Pennsylvania. Between 1970 and 1982, Cryochem reportedly used chemical solvents to clean dye from metal welds at a rate of two to three 55-gallon drums per year. The facility also reported that a solvent spill had occurred at some unspecified time in the past. Spilled solvent is suspected to have collected in the workshop drains and flowed, through underground channels, towards a stream that flows across the site. Spilled solvent has also migrated through the soil column and has contaminated the ground water underlying the site. Ground water samples, collected between 1981 and 1985 by the State and EPA, revealed that an onsite production well, nearby residential wells, and onsite soil have been contaminated. As a result of drinking water contamination, EPA installed activated carbon filters in 13 homes in 1987. The primary contaminants of concern affecting the ground water are VOCs including TCA, DCA, TCE, DCE, and PCE.

29092 (PB–90-162785/XAB) **Superfund Record of Decision (EPA Region 5): Hedblum Industries, MI. (First remedial action), September 1989. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 59p. (EPA/ROD/R–05-89/112). Available from NTIS, PC A04/MF A01.

Hedblum Industries site, an automotive parts manufacturing plant, is approximately one mile southwest of the town of Oscoda, in AuSable Township, Iosco County, Michigan. Ground water flows beneath the plant and subdivision and discharges via a bayou into the AuSable River. Between 1968 and 1972 the previous plant operators discharged cooling water, rinse water, and approximately 4,000 gallons of waste TCE onto the ground. In 1973 VOCs were detected in residential wells in the AuSable subdivision. Contaminated wells were replaced with deeper wells which by 1977 also showed traces of contamination. Subsequently, the Oscoda Township Municipal Supply System was extended to residents through the installation of a new water main. An underground storage tank containing TCE, TCA, and PCE was removed from the site in 1980. The primary contaminants of concern affecting the ground water are VOCs including benzene, toluene, xylenes, TCE, and PCE; and metals including lead. The selected remedial action for the site includes ground water pumping and treatment using activated carbon adsorption with discharge to the bayou; and ground water and soil monitoring. The estimated present worth cost of the remedial action is $2,379,000, which includes an annual O&M cost of $264,000 over 4-5 years.

29093 (PB–90-162801/XAB) **Superfund Record of Decision (EPA Region 1): South Municipal Water Supply Well, BH. (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 27 Sep 1989. 129p. (EPA/ROD/R–01-89/044). Available from NTIS, PC A07/MF A01.

The 250-acre South Municipal Water Supply Well site is near the Town of Peterborough, in Hillsborough County, New Hampshire. Also on the site are the New Hampshire Ball Bearings Incorporated (NHBB) manufacturing facility, several commercial establishments, and several apartments. The town of Peterborough discontinued use of the South Well in May 1983 after the State discovered VOC contamination in water samples taken from the well. Subsequent investigations revealed that a plume of contaminated ground water extended from under the NHBB property to the vicinity of the South Well. VOC contamination was also detected in soil on the NHBB property, and wetlands sediment was found to be contaminated with PCBs, metals, and PAHs. Investigations attributed the contamination to in-house chemical releases that were subsequently washed out through floor drains or slop sinks to outfalls, or washed out through facility doors. Exterior releases contributed to contamination at the site through the draining of a truck-mounted waste solvent tank. The primary contaminants of concern affecting the soil and ground water are VOCs including PCE, TCE, and toluene; the primary contaminants of concern affecting the sediment are organics including PCBs and PAHs, and metals.

29094 (PB–90-162942/XAB) **Superfund Record of Decision (EPA Region 5): Alsco Anaconda, OH. (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 8 Sep 1989. 54p. (EPA/ROD/R–05-89/102). Available from NTIS, PC A04/MF A01.

The Alsco Anaconda site is a 4.8-acre former sludge disposal area in Gnadenhutten, Tuscarawas County, Ohio. Contamination at the site occurred from 1965 to 1978 when wastewater and wastewater treatment sludge from the plant, containing hazardous aluminum processing wastes (FO19), was disposed of in an unlined settling basin and a sludge pit. In 1978 the plant owners began dewatering the treatment sludge prior to disposal of sludge offsite in the settling basin and a former swamp area. Because leachate from the sludge may have contaminated the ground water and surface water, a subsequent ROD will address the appropriate remedial action for those media. The primary contaminants of concern affecting the soil and sludge are organics including PCBs, and metals including chromium, cyanide, and arsenic.

29095 (PB–90-163544/XAB) **Superfund Record of Decision (EPA Region 1): W. R. Grace Acton, Massachusetts (First remedial action), September 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1989. 211p. (EPA/ROD/R–01-89/040). Available from NTIS, PC A10/MF A02.

The W.R. Grace (Acton Plant) site is in Acton and Concord, Massachusetts. In 1954 W.R. Grace & Company purchased the property and began producing container sealing compounds, latex products, and paper and plastic battery separators. Effluent wastes from these operations flowed into several unlined lagoons and were later buried in onsite waste areas, including an industrial landfill. After a 1978 investigation revealed that ground water in the vicinity of the site was contaminated with VOCs, W.R. Grace & Company agreed to fully restore the aquifer. An aquifer restoration system was installed in 1985 which recovers and treats ground water under the site's waste disposal areas. Subsequent samplings, however, have indicated that the system has only minimally reduced the ground water contamination at the site. This first operable unit primarily addressed the source contamination and includes minimal modifications to the aquifer restoration system. Further ground water remediation will be addressed in a subsequent Record of Decision. The primary contaminants of concern affecting the soil, sediment, and sludge are VOCs including benzene and toluene, other organics, and metals including arsenic.

29096 (PB–90-164138/XAB) **Piecewise SALT (Selection At List Time) sampling for estimating suspended sediment yields. Forest Service general technical report (Final).** Thomas, R.B. Forest Service, Berkeley, CA (USA). Pacific Southwest Forest and Range Experiment Station. Jul 1989. 18p. (FSGTR-PSW–114). Available from NTIS, PC A03/MF A01.

A probability sampling method called SALT (Selection At List Time) has been developed for collecting and summarizing data on delivery of suspended sediment in rivers. It is based on sampling and estimating yield using a suspended-sediment rating curve for high discharges and simple random sampling for low flows. The method gives unbiased estimates of total yield and variance. The technique has been modified by replacing the rating curve with a user-specified average sampling rate function. This function allows easier specification of field sampling parameters for specified conditions and helps avoid the extremes of data collection. It also improves the distribution of samples if the intent is to estimate suspended sediment yield during storms specified after data collection. This form of SALT sampling is called piecewise SALT sampling.

29097 (PB–90-164849/XAB) **Proximity of Washington sanitary landfills to wetlands and deepwater habitats: Statewide resWults.** Moerlins, J.E.; Herndon, R.C.; Lambou, V.W.; Gebhard, R.L. Florida State Univ., Tallahassee, FL (USA). Center for Biomedical and Toxicological Research and Hazardous Waste Management. Feb 1990. 33p. Available from NTIS, PC A03/MF A01.

See also PB–90-164856.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. The purpose of the reports are to summarize the proximity of sanitary landfills in Washington to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.) and present data on the individual landfills. The sanitary landfills were identified on U.S. Fish and Wildlife Service's National Wetlands Inventory maps. These facilities have the potential to adversely affect sensitive ecosystems, such as wetlands and deepwater habitats, either through habitat alterations or through the migration of contaminants from sanitary landfills.

29098 (PB–90-164930/XAB) **Available disposal capacity for solid waste in Illinois: Third annual report.** Illinois Environmental Protection Agency, Springfield, IL (USA). Div. of Land Pollution Control. Dec 1989. 118p. (IEPA/LPC–89/902). Available from NTIS, PC A06/MF A01.

See also PB–89-134761.

Under the Illinois Solid Waste Management Act, IEPA is required to publish an annual report on the remaining landfill capacity in Illinois. It is the third annual report published by the IEPA. It details data on volumes of waste accepted at landfills in each county, as well as the reported remaining landfill capacity by county and region.

29099 (PB–90-165556/XAB) **Proximity of New Jersey sanitary landfills to wetlands and deepwater habitats: Statewide results.** Herndon, R.C.; Moerlins, J.E.; Lambou, V.W.; Gebhard, R.L. Florida State Univ., Tallahassee, FL (USA). Center for Biomedical and Toxicological Research and Hazardous Waste Management. Feb 1990. 33p. Available from NTIS, PC A03/MF A01.

See also PB–90-165564.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. The purpose of the reports are to summarize the proximity of sanitary landfills in New Jersey to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.) and present data on the individual landfills. Most sanitary landfills in New Jersey are located in or are close to either wetlands or deepwater habitats. All are located close to wetlands while more than half are close to deepwater habitats.

29100 (PB–90-165564/XAB) **Proximity of New Jersey sanitary landfills to wetlands and deepwater habitats: data on individual landfills.** Herndon, R.C.; Moerlins, J.E.; Lambou, V.W.; Gebhard, R.L. Florida State Univ., Tallahassee, FL (USA). Center for Biomedical and Toxicological Research and Hazardous Waste Management. Feb 1990. 26p. Available from NTIS, PC A03/MF A01.

See also PB–90-165556.

Sanitary landfills can cause considerable harm to sensitive ecosystems if they are not properly located, designed, and managed. The purpose of the report is to document the proximity of sanitary landfills included in the study in New Jersey to wetlands and deepwater habitats (i.e., rivers, lakes, streams, bays, etc.). The sanitary landfills were identified on U.S. Fish and Wildlife Service's National Wetlands Inventory maps. The data on individual landfills include: (1) general facility/site data, and (2) wetlands/deepwater habitat data.

29101 (PNRI-C(HP)–89010) **Radiological impact assessment of the hydrological characteristics of the area around PRR-1.** Paz, L.R. de la (Radiological Impact Assessment, Nuclear Regulations, Licensing and Safeguards Division, Philippine Nuclear Research Institute, Quezon City (Philippines)); — Palattao, M.V.B. Philippine Nuclear Research Inst., Diliman, Quezon City (Philippines). 1989. 27p. Order Number DE90624480. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The hydrologic characteristics of the PRR-1 site are discussed. A study of the rainfall and thyphoon behaviour in the areas around the site is made and the maximum precipitation characteristic is computed, with the probable maximum precipitation calculated as 1383.9 mm. The possible effects of accidental release of radioactivity on streams and waterways are discussed. An evaluation of the PNRI drainage system is made. (Author). 5 tabs.; 9 figs.; 9 refs.

29102 (UCRL–21008-Vol.4-Pt.2) **Evaluation of military field-water quality: Volume 4, Health criteria and recommendations for standards: Part 2, Interim standards for selected threat agents and risks from exceeding these standards.** Daniels, J.I. (ed.); Anspaugh, L.R.; Layton, D.W. Lawrence Livermore National Lab., CA (USA). Jan 1990. 185p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. Order Number DE90009942. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

The purpose of this report is to develop drinking-water standards for field water for selected threat agents of concern, including radioactivity. The threat agents of concern in addition to radioactivity are the classical chemical-warfare compounds hydrogen cyanide, organophosphorus nerve agents, and lewisite, as well as a fungal metabolite identified only recently as a possible threat agent, the trichothecene mycotoxin. The recommended standards are applicable only to military personnel deployed in the field, and they are meant to protect against performance-degrading effects resulting from the ingestion of the substances in field water. 25 refs., 11 figs., 19 tabs.

29103 (UCRL–102124) **Particle-grid methods for reacting flows in porous media: Application to Fisher's Equation.** Tompson, A.F.B. (Lawrence Livermore National Lab., CA (USA)); Dougherty, D.E. Lawrence Livermore National Lab., CA (USA). Feb 1990. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9006156–1: 8. international conference on computational methods in water resources, Venice (Italy), 11-15 Jun 1990). Order Number DE90009437. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Recent investigations have shown the particle tracking method to be a viable and efficient method for solving equations describing nonreactive mass transport in porous media. The approach is particularly useful for solving multidimensional, densely gridded problems, is readily implemented on parallel and vector architecture computers, and may be extended for use in multicomponent or nonconservative problems. In this paper, we briefly outline a specific framework in which the method can be applied to reactive problems and demonstrate its use to solve a particular diffusion-reaction system described by the so-called Fisher's Equation. 12 refs., 2 figs.

29104 (UCRL–102781) **Cooperative LLNL/HAZWRAP project to demonstrate determination of field-based retardation factors: Part 3: Algorithm to determine a field-based retardation factor.** Rogers, L.L.; Rice, D.W. Jr.; Bishop, D.J.; Stout, N.D. Lawrence Livermore National Lab., CA (USA). Jan 1990. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900210–45: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90009578. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Current limitations of field and laboratory technologies make it difficult to determine a distribution coefficient which is necessary to calculate a field-based retardation factor. At Lawrence Livermore

National Laboratory, an ongoing study is refining a method to assess the existing partitioning of trichloroethylene (TCE) and perchloroethylene (PCE) between the solid and liquid phases of the aquifer system. The three main components of this method involve (1) measurement of the total VOCs in saturated alluvial deposits, (2) measurement of sediment properties, and (3) measurement of the VOCs in pore water. The design and implementation of new measurement techniques and protocols are being compared to traditional measurement protocols. An overview of these new measurement protocols is presented here along with the algorithm that calculates the field-based retardation factors. A sensitivity analysis is presented to demonstrate the required accuracy of the individual measurements needed to meet the desired accuracy of the final retardation factors. 13 refs., 6 figs., 1 tab.

29105 (UCRL–102790) **Cooperative LLNL/HAZWRAP project to demonstrate determination of field-based retardation factors: Part 2, Determination of sorption constants.** Bishop, D.J.; Rice, D.W. Jr.; Rogers, L.L. Lawrence Livermore National Lab., CA (USA). Jan 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900210–43: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90009580. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In a demonstration of methods to measure field-based retardation factors, a number of investigations are underway to determine the relationship between field-based measurements for calculating sorption constants (K_ds) and those determined from batch sorption experiments in the laboratory. Field-based (K_ds) are site or sediment specific, and laboratory (K_ds) provide an upper boundary for sorption capacity. Studies have been initiated to predict the rate and extent of lateral and vertical migration of volatile organic compounds (VOCs) in ground water beneath and in the vicinity of the Lawrence Livermore National Laboratory (LLNL) site in Livermore, California. A preliminary ground water study of this area indicated the presence of VOCs, primarily perchloroethylene and trichloroethylene, generally in the tens of parts-per-billion range. Cores from the completion zone of approximately 50 different LLNL monitor wells were selected for analysis for a number of physical and chemical properties including organic carbon content, cation exchange capacity, and grain size distribution. Additionally, cores from the saturated and unsaturated zones of four HAZWRAP-sponsored boreholes were studied. (K_ds) were determined from sorption experiments performed on samples from each of the cores. A pooled group of cores from one borehole was separated into sand, silt, and clay fractions that were individually analyzed. 15 refs., 3 figs., 3 tabs.

29106 (UCRL–102859) **Cooperative LLNL/HAZWRAP project to demonstrate determination of field-based retardation factors: Part 1, Distribution of perchloroethylene around and within permeable zones in saturated alluvial deposits.** Rice, D.W. Jr.; Bishop, D.J.; Rogers, L.L. Lawrence Livermore National Lab., CA (USA). Jan 1990. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900210–44: 16. annual waste management symposium: working towards a cleaner environment, Tucson, AZ (USA), 25 Feb - 1 mar 1990). Order Number DE90009577. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

As part of a cooperatively sponsored HAZWRAP and Lawrence Livermore National Laboratory (LLNL) project to evaluate field-based methods to measure retardation factors, we investigated some aspects of the variability associated with measuring the concentrations of perchloroethylene (PCE) within the saturated unconsolidated alluvial sediments beneath LLNL. Using the depth-sampling technique developed at LLNL, we are describing the relationship of VOC spatial variability to various sediment characteristics such as geophysical log results, grain size distribution, cation exchange capacity, total organic carbon, permeability, bulk density, skeletal density, and porosity. An algorithm is being developed to calculate representative field-based partitioning coefficients and retardation factors (R). The two major sources of sediment PCE concentration variability examined were those associated with the analytical extraction methods and the spatial changes in fine-grained materials within permeable and confining sediments. To evaluate desorption efficiency during headspace extraction for VOC analyses, a bulk thermal desorption chamber (BTDC) was constructed and calibrated. We used both headspace and BTDC analytical results to describe the vertical distribution of PCE in four adjacent boreholes. 14 refs., 6 figs., 1 tab.

29107 (WHC-EP–0145-1) **Westinghouse Hanford Company environmental surveillance annual report--200/600 Areas, calendar year 1988.** Elder, R.E.; McKinney, S.M.; Osborne, W.L. Westinghouse Hanford Co., Richland, WA (USA). May 1989. 127p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE90008201. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This document presents the results of near-field environmental surveillance as performed by Westinghouse Hanford Company in 1988 of the Operations Area of the Hanford Site, Washington State. These activities are conducted in the 200 and 600 Areas to assess and control the impacts of operations on the worker and the local environment. Surveillance activities include sampling and analysis of ambient air, surface water, groundwater, sediments, soil, and biota. External radiation measurements and radiological surveys of waste disposal sites, radiological control areas, and roads are also performed. 18 refs., 3 figs.

29108 Hydrology, community structure, and productivity patterns of a dystrophic Carolina bay wetland. Schalles, J.F. (Creighton Univ., Omaha, NE (USA)); Shure, D.J. *Ecological Monographs (USA)*, 59(4): 365-385 (Dec 1989).

A shallow, 5.4-ha dystrophic Carolina bay wetland was studied between 1974 and 1978 to test the premise that biomass and production are constrained by the stagnant hydrology and dilute, acidic chemistry of bay wetlands. Our objectives were to evaluate: (1) surface and subsurface hydrology, (2) sources of production, (3) community change along a depth gradient, and (4) seasonal community patterns. The hydrology study compared surface water levels to groundwater levels in four adjacent wells. A cylinder enclosure and total harvest procedure and 24-h dissolved oxygen curves were used for 2 yr in a 1-ha sampling area to measure spatial and temporal biomass patterns and organic production of community components.

29109 Experimental verification of multicomponent ground water contamination predictions. Clancy, K.M. (Waste Management Division, Lansing, MI (USA)); Jennings, A.A. *Water Resources Bulletin (USA)*, 24(2): 307-316 (Apr 1988). DOE Contract AC02-79EV10253.

Recent advances in mass transport modeling have made possible computation of the theoretical consequences of intricate multicomponent species interactions during ground water contamination events. Predictions such as strong chromatographic effects and induced downstream precipitations may have considerable impact on environmental analysis and regulation. Results of laboratory attempts to verify theoretical multicomponent transport predictions of energy-related contaminants such as cadmium, zinc, arsenic and selenium are discussed. Evidence presented here indicates that natural variability of soil properties make such verifications difficult. Although species interactions are easily confirmed, dramatic effects often exist only within small mathematical windows in strongly variable coefficient sets. Currently, the ability to generate multicomponent predictions apparently exceeds the ability to quantify the necessary, presumably deterministic, information required for real soils.

29110 Model predictions of watershed erosion components. Hetrick, D.M. (Oak Ridge National Laboratory, TN (USA)); Travis, C.C. *Water Resources Bulletin (USA)*, 24(2): 413-419 (Apr 1988). DOE Contract AC05-84OR21400.

Model predictions for surface runoff and sediment yield from the coupled SESOIL/EROS soil compartment model are compared with empirical measurements from three watersheds. The model is summarized and descriptions are given for the two corn field watersheds and one grassland watershed used in the analysis. Model performance and limitations are discussed.

29111 Polymer bead containing immobilized metal extractant. Seidel, D.; Jeffers, T. To Department of the Interior, Washington, DC (US). USA Patent Application 7-429,326. 18 Oct 1989. 16p. Available from NTISPC N03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

The invention relates to the preparation of beads containing immobilized extractants of either biomass material, organic solvents or mixtures of biomass material and organic solvent materials. These beads are used to effectively remove metal contaminants present in low concentrations from dilute solutions, such as processing streams and waste waters. Removal of the metal values from these extractants is accomplished by using dilute mineral acids or other dilute solutions to solubilize the metal.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

Refer also to citation(s) 28595

29112 (BNL–44468) **Is life a critical phenomenon?** Bak, Per; Chen, Kan. Brookhaven National Lab., Upton, NY (USA). [1989]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-8909298–3: NATO conference on cellular automata, Los Alamos, NM (USA), 6-9 Sep 1989). Order Number DE90010020. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The "Game of Life" evolves into a self-organized critical state. Implications for biological evolution are discussed.

5501 Behavioral Biology

Refer also to citation(s) 27795, 29147

5502 Biochemistry

Refer also to citation(s) 27810, 29164, 29253, 29254, 29259, 29890

29113 (AD-A–217017/3/XAB) **Key involvement of poly (ADP-ribosylation) in defense against toxic agents in molecular biology studies. Annual report, November 1988-November 1989.** Smulson, M.E. Georgetown Univ., Washington, DC (USA). School of Medicine. 15 Nov 1989. 15p. Available from NTIS, PC A03/MF A01.

The program has 3 interrelated aims. The first stage involves recombinant construction of polymerase cDNA into a family of selected expression vectors which in most cases will possess an inducible promoter. During the first year, the cDNA was inserted in both sense and antisense orientations and also site-directed mutants. We were also concerned with construction (I-D) and expression of site-directed mutants and potential inhibitory peptides in vivo in order to eventually modulate the activity of poly(ADP-Rib) polymerase in cells, upon induction during DNA repair. Various expression vectors will be stably transfected into eukaryotic cells generally by co-transfection with a selectable gene. We expect various levels of overexpression and underexpression of poly(ADP-Rib) polymerase. In the case of the site-directed mutants and the inhibitory peptides (IID), we anticipate cells with reduced capacity for ADP-ribosylation. Biochemical and molecular biological characterizations of the gene products of the various transfected cells are proposed prior to cytotoxicity or DNA repair analysis. These will include: Southern analysis to confirm integrated copies of the cDNA; both Northern and primer extension analysis of cellular mRNA to confirm that upon induction actual expression of the foreign gene occurs; and immunoprecipitation of poly(ADP-Rib) polymerase in vivo after induction.

29114 (DOE/ER/13198–4) **Structure and function of Frankia vesicles in dinitrogen fixing actinorhizal plants: Final report, April 1, 1984–December 31, 1989.** Torrey, J.G. Harvard Univ., Petersham, MA (USA). Harvard Forest. [1990]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER13198. Order Number DE90009460. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Frankia, a filamentous bacterium which induces N_2-fixing root nodules on the roots of a wide range of woody dicotyledonous plants, is the first known actinomycete which fixes dinitrogen when growing in free-living culture. The nitrogenase enzyme is induced in many strains of this organism by withholding fixed nitrogen compounds from its nutrient medium. Our studies have concerned the physiology, biochemistry and structural development of the N_2-fixing apparatus in Frankia grown in vitro and in root nodules of host plants. Diverse strains of Frankia were isolated and cultured from different host plants and vesicle form and function were studied. Two strains were studied, HFPArI3, an isolate from nodules of the red alder Alnus rubra and HFPCcI3 isolated from root nodules of the tropical tree Casuarina cunninghamiana. The goal was to understand the structure and function which leads to optimum effectiveness for dinitrogen fixation. 13 refs.

29115 (DOE/ER/13704–3) **[Processing and targeting of the thiol protease aleurain]: Progress report.** Rogers, J.C. Washington Univ., St. Louis, MO (USA). Dept. of Hematology and Oncology. [1990]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER13704. Order Number DE90009522. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Our goal for work during the past two years under this Grant was to characterize the barley thiol protease, aleurain, to determine if it is secreted or retained intracellularly in aleurone cells, and to begin to elucidate structural features that might control targeting of the protein to its final destination. We have shown that aleurain is synthesized as a proenzyme with two N-linked oligosaccharide chains, one high mannose-type and one complex-type. Aleurain undergoes processing to mature form by removal of an Nterminal prosegment, and is retained intracellularly; it cannot be detected among proteins secreted from aleurone cells. Treatment of aleurone cells with tunicamycin to prevent glycosylation of aleurain does not prevent processing of the unglycosylated form. The N-terminal portion of aleurain's prosegment is homologous to the comparable region in two yeast vacuolar proteases, where that region is known to contain the signal necessary for targeting the proteases to the vacuole. 18 refs., 7 figs.

29116 (DOE/ER/14006–1) **[Calcium gated proton fluxes in energy transducing membranes]: Progress report, April 1, 1989–December 19, 1989.** Dilley, R.A. Purdue Univ., Lafayette, IN (USA). 19 Dec 1989. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER14006. Order Number DE90009506. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Short communication. ATP/biosynthesis; THYLAKOID MEMBRANE PROTEINS/coupling; PROGRESS REPORT; ATP; BIOSYNTHESIS; PROTONS; COUPLING; CALCIUM IONS; STEADY-STATE CONDITIONS; KINETICS; HYDROGEN IONS; LABELLED COMPOUNDS; CHLOROPLASTS

29117 (LA-UR–90-705) **Real-time Fourier transform spectrometry for fluorescence imaging and flow cytometry.** Buican, T.N. Los Alamos National Lab., NM (USA). [1990]. 9p. Sponsored by U.S. Department of Health and Human Services. DOE Contract W-7405-ENG-36. (CONF-900140–20: SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition, Los Angeles, CA (USA), 15-19 Jan 1990). Order Number DE90008992. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We present a Fourier transform (FT) spectrometer that is suitable for real-time spectral analysis in fluorescence imaging and flow cytometry. The instrument consists of a novel type of interferometer that can be modulated at frequencies of up to 100 kHz and has a high light throughput; and a dedicated, parallel array processor for the real-time computation of spectral parameters. The data acquisition array processor can be programmed by a host computer to perform any desired linear transform on the interferogram and can thus separate contributions from multiple fluorescence microscopy. The integration of a flow cytometer and a spectral imaging fluorescence microscope is discussed, and the concepts of direct and reversed "virtual sorting" are introduced. 9 refs., 8 figs.

29118 Extraction of pectins and hemicelluloses from cell walls of suspension culture cells of cotton by endopolygalacturonase treatment. An, Jinhua (Oklahoma State Univ., Stillwater (USA)); Maness, N.O.; Mort, A.J. *Plant Physiology, Supplement (USA)*, 89(4): 142 (Apr 1989).

Walls of cotton suspension cultures were treated with a highly purified endopolygalacturonase coded for by a gene from Erwinia carotovora expressed in E. coli. About 80 percent of the walls galacturonic acid was solubilized and could be fractionated by ion exchange chromatography into three classes: (1) tri- and tetragalacturonides from digestion of homogalacturonans, (2) high molecular weight fragments rich in galacturonic acid, rhamnose and other neutral sugars indicative of rhamnogalacturonan I, and (3) a well defined low molecular weight polymer resembling rhamnogalacturonan II. Treatment of the insoluble wall residue with alkali allowed extraction of the remainder of the wall galacturonic acid as high molecular weight polymers resembling rhamnogalacturonan I but in association with what is probably xyloglucan. The purified polymers will be compared to those obtained by others from different species, especially those of sycamore.

29119 A new method for measuring degree of methyl esterification in pectin. Maness, N.O. (Oklahoma State Univ., Stillwater (USA)); Ryan, J.D.; Mort, A.J. *Plant Physiology, Supplement (USA)*, 89(4): 142 (Apr 1989).

A simple method to measure the degree of methyl esterification in small samples of pectins or isolated cell walls will be described. The method involves selective reduction of methyl esterified galacturonic acid to galactose with sodium borohydride or sodium borodeuteride in the presence of strong buffer at 4 C. Quantitative reduction of samples can be accomplished in 1 h using 20 mg borohydride per mg sample. The degree of pectin methyl esterification can then be determined by measuring an increase of galactose using gas chromatography (borohydride reduced samples) or gas chromatography/mass spectroscopy (borodeuteride reduced samples), or by measuring the decrease in galacturonic acid using conventional colorimetric methods. Pectin samples as small as 50 μg have been analyzed using the reduction method with good results.

29120 Early changes in protein expression of barley following inoculation with erysiphe graminis f. sp. hordei. Simons, S.P. (Michigan State Univ., East Lansing (USA)); Somerville, S.C. *Plant Physiology, Supplement (USA)*, 89(4): 165 (Apr 1989).

Erysiphe graminis f. sp. hordei is an obligate pathogen of barley causing the powdery mildew disease. Resistance to this disease is the product of a highly specific interaction between barley lines with specific resistance alleles and pathogen races carrying complementary avirulence alleles. Using congenic barley lines which differ at the M1-a disease reaction locus, we hope to define the early molecular events of this interaction. Accordingly, resistant and susceptible barley seedlings were labelled with ^{35}S-methionine and examined by two-dimensional electrophoresis at two hour intervals following inoculation. Infection related changes were observed with both isolines during the four to twelve hour time period. Additional differences existed constitutively between the barley lines. These differences have been quantified. Further characterization of these proteins will yield useful markers for events preceding or coinciding with cytological responses any may lead to identification and cloning of the M1-a gene.

29121 The bean α-amylase inhibitor is encoded by a lectin gene. Moreno, J. (Univ. of California, San Diego, La Jolla (USA)); Altabella, T.; Chrispeels, M.J. *Plant Physiology, Supplement (USA)*, 89(4): 169 (Apr 1989).

The common bean, Phaseolus vulgaris, contains an inhibitor of insect and mammalian α-amylases that does not inhibit plant α-amylase. This inhibitor functions as an anti-feedant or seed-defense protein. We purified this inhibitor by affinity chromatography and found that it consists of a series of glycoforms of two polypeptides (Mr 14,000-19,000). Partial amino acid sequencing was carried out, and the sequences obtained are identical with portions of the derived amino acid sequence of a lectin-like gene. This lectin gene encodes a polypeptide of MW 28,000, and the primary in vitro translation product identified by antibodies to the α-amylase inhibitor has the same size. Co- and posttranslational processing of this polypeptide results in glycosylated polypeptides of 14-19 kDa. Our interpretation of these results is that the bean lectins constitute a gene family that encodes diverse plant defense proteins, including phytohemagglutinin, arcelin and α-amylase inhibitor.

29122 Phenotypic expression of wild-type tomato and three wilty mutants in relation to abscisic acid accumulation in roots and leaflets of reciprocal grafts. Cornish, K. (Michigan State Univ., East Lansing (USA)); Zeevaart, J.A.D. *Plant Physiology (USA)*, 87(1): 190-194 (May 1988). DOE Contract AC02-76ER01338.

Lycopersicon esculentum Mill. cv Rheinlands Ruhm (RR) and cv Moneymaker and the three wilty mutants flacca (flc), sitiens (sit), and sitiens^{w} (sit^{w}), together with the most reciprocal grafts, were grown in pots and in solution culture. Detached leaflets, and control and stem-girdled intact plants, were left turgid or were wilted in air. Detached leaflets and the leaflets and roots of the intact plants were analyzed for their abscisic acid (ABA) content. Turgid RR leaflets contained about 2.9 ng ABA per miligram dry weight. On average, the flc and sit leaflets contained 33 and 11% of this amount, respectively. The lack of ABA approximately correlated with the severity of the mutant phenotype. Mutant roots also contained less ABA than wild-type roots. Wild-type scions on mutant stocks (wild type/mutant) maintained the normal phenotype of ungrafted plants. Mutant scions grafted onto wild-type stocks reverted to a near wild-type phenotype. After the wild-type leaves were excised from solution culture-grown mutant/wild-type plants, the revertive morphology of the mutant scions was maintained, although endogenous ABA levels in the leaflets fell to typical mutant levels and the leaflets became wilty again. When stressed in air, both leaflets and roots of RR plants produced stress-induced ABA, but the mutant leaflets and roots did not. The roots and leaflets of the grafted plants behaved according to their own genotype, with the notable exception of mutant roots grown with wild-type scions. Roots of flc and sit^{w} recovered the ability to accumulate stress-induced ABA when grafted with RR scions before the stress was imposed.

29123 Immunocytochemical localization of the vacuolar H^{+}-ATPase in maize root tip cells. Hurley, D. (Univ. of California, Santa Cruz (USA)); Taiz, L. *Plant Physiology (USA)*, 89(2): 391-395 (Feb 1989). DOE Contract FG03-84ER13245.

The vacuolar H^{+}-ATPase of maize (Zea mays L.) root tip cells has been localized at the EM level using rabbit polyclonal antibodies to the 69 kilodalton subunit and protein A-colloidal gold. Intracellular gold particles were detected mainly on the tonoplast and Golgi membranes. Only about 27% of the vacuoles were labeled above background. The absence of gold particles on the majority of vacuoles suggests either that the tonoplast H^{+}-ATPase is degraded during tissue preparation or that the small vacuoles of root tip cells are specialized with respect to H^{+}-ATPase activity. The pattern of gold particles on the labeled vacuoles ranged from uniform to patchy. Virtually all of the Golgi bodies were labeled by the antibody, but the particle densities were too low to determine whether the H^{+}-ATPase was associated with specific regions, such as the trans-face. Cell wall-labeling was also observed which could be partially prevented by the inclusion of gelatin as a blocking agent. The immunocytochemical results confirm previous biochemical studies with isolated membrane fractions.

29124 N-terminus conservation in the terminal pigment of phycobilisomes from a prokaryotic and eukaryotic alga. Gantt, E. (Smithsonian Institution, Washington, DC (USA)); Cunningham, F.X. Jr.; Lipschultz, C.A.; Mimuro, M. *Plant Physiology (USA)*, 86(4): 996-998 (Apr 1988). DOE Contract AS05-76ER04310.

High molecular weight polypeptides from phycobilisomes, believed to be involved in facilitating the energy flow from phycobilisomes to thylakoids, are conserved in the prokaryote Nostoc sp. and the eukaryote Porphyridium cruentum. Partial N-terminal sequence analysis of the phycobilisome-polypeptides of Nostoc (94 kilodalton) and Porphyridium (92 kilodalton) revealed 55% identity in the first 20 residues, but no significant homology with sequences of other phycobiliproteins or phycobilisome-linkers. Polypeptides (94 and 92 kilodalton) from Nostoc thylakoids free of phycobilisomes, previously presumed to be involved in the phycobilisome-thylakoid linkage exhibit the same immunocrossreactivity but are different

from the 94 kilodalton-phycobilisome polypeptide by having blocked N-termini and a different amino acid composition.

29125 Induction and accumulation of heat shock-specific poly(A+) RNAs and proteins in soybean seedlings during arsenite and cadmium treatments. Edelman, L. (Univ. of Georgia, Athens (USA)); Czarnecka, E.; Key, J.L. *Plant Physiology (USA)*, 86(4): 1048-1056 (Apr 1988). DOE Contract AS09-80ER10678.

Northern blot hybridization analyzes revealed that poly(A+) RNAs homologous to eight heat shock (HS)-specific cDNA clones were induced by arsenite (As) or Cd treatments. The mRNAs accumulated slower, and maximum accumulations were consistently lower than HS-induced levels. Prolonged treatment with low concentrations (50-100 micromolar) of As for 6 hours, or Cd for 12 hours, resulted in decreased accumulations of HS-specific mRNAs. This response resembled the autoregulation observed during continuous 40°C HS. However, no autoregulation was evident when soybean seedlings were exposed to high concentrations of As (250 micromolar) or Cd (1 millimolar) for 12 hours. The cDNA probe pCE54 detected a second higher molecular weight poly(A+) RNA following As or Cd treatments which accumulated concomitantly with the lower molecular weight HS-specific poly(A+) RNA. The patterns of low molecular weight HS polypeptides from in vitro translations induced by HS, As, and Cd, and analyzed by one-dimensional and two-dimensional SDS-PAGE, were similar but temporal differences were apparent. The chemical agents used in this study apparently induced the accumulation and translation of HS messages in vivo but not in the selective manner as observed during HS treatment.

29126 Cloning of a Thermomonospora fusca xylanase gene and its expression in Escherichia coli and Streptomyces lividans. Ghangas, G.S. (Cornell Univ., Ithaca, NY (USA)); Hu, Y.J.; Wilson, D.B. *Journal of Bacteriology (USA)*, 171(6): 2963-2969 (Jun 1989). DOE Contract FG02-84ER13233.

Thermomonospora fusca chromosomal DNA was partially digested with EcoRI to obtain 4- to 14-kilobase fragments, which were used to construct a library of recombinant phage by ligation with EcoRI arms of λgtWES.λB. A recombinant phage coding for xylanase activity which contained a 14-kilobase insert was identified. The xylanase gene was localized to a 2.1-kilobase SalI fragment of the EcoRI insert by subcloning onto pBR322 and derivatives of pBR322 that can also replicate in Streptomyces lividans. The xylanase activity produced by S. lividans transformants was 10- to 20-fold higher than that produced by Escherichia coli transformants but only one-fourth the level produced by induced T. fusca. A 30-kilodalton peptide with activity against both Remazol brilliant blue xylan and xylan was produced in S. lividans transformants that carried the 2.1-kilobase SalI fragment of T. fusca DNA and was not produced by control transformants. T. fusca cultures were found to contain a xylanase of a similar size that was induced by growth on xylan or Solka Floc. Antiserum directed against supernatant proteins isolated from a Solka Floc-grown T. fusca culture inhibited the xylanase activity of S. lividans transformants. The cloned T. Fusca xylanase gene was expressed at about the same level in S. lividans grown in minimal medium containing either glucose, cellobiose, or xylan. The xylanase bound to and hydrolyzed insoluble xylan. The cloned xylanase appeared to be the same as the major protein in xylan-induced T.fusca culture supernatants, which also contained at least three additional minor proteins with xylanase activity and having apparent molecular masses of 43, 23, and 20 kilodaltons.

29127 N_2O reduction and HD formation by nitrogenases from a nifV mutant of Klebsiella pneumoniae. Liang, J. (Univ. of Wisconsin, Madison (USA)); Burris, R.H. *Journal of Bacteriology (USA)*, 171(6): 3176-3180 (Jun 1989). DOE Contract FG02-87ER13707.

Dinitrogenase from a nifV mutant of Klebsiella pneumoniae contains an altered form of iron-molybdenum cofactor (FeMoco) that lacks a biologically active homocitric acid molecule. Change in the composition of FeMoco led to substantial variation in the kinetics of nitrogenase action. The K_ms of the mutant enzyme for N_2 and N_2O were 0.244 and 0.175 atm (24,714 and 17,726 kPa), respectively. The K_m for N_2 was higher and the K_m for N_2O was lower than that for the wild-type enzyme. The mutant enzyme was ineffective in N_2 fixation, in N_2O reduction, and in HD formation, as indicated by the low V_{max} of these reactions with saturating levels of substrate and under conditions of saturating electron flux. These observations provide further support for the concept that N_2, N_2O, and D_2 interact with the same form of dinitrogenase. H_2 evolution by the mutant enzyme is only partially inhibited by CO. Observation that different numbers of electrons are stored in CO-inhibited than in noninhibited dinitrogenase before H_2 is released suggests that the mutant enzyme has more sites responsible for H_2 evolution than the wild-type enzyme, whose H_2 evolution is not inhibited by CO.

29128 Ammonium inhibition of nitrogenase activity in Herbaspirillum seropedicae. Fu, H. (Univ. of Wisconsin, Madison (USA)); Burris, R.H. *Journal of Bacteriology (USA)*, 171(6): 3168-3175 (Jun 1989). DOE Contract FG02-87ER13707.

The effect of oxygen, ammonium ion, and amino acids on nitrogenase activity in the root-associated N_2-fixing bacterium Herbaspirillum seropedicae was investigated in comparison with Azospirillum spp. and Rhodospirillum rubrum. H. seropedicae is microaerophilic, and its optimal dissolved oxygen level is from 0.04 to 0.2 kPa for dinitrogen fixation but higher when it is supplied with fixed nitrogen. No nitrogenase activity was detected when the dissolved O_2 level corresponded to 4.0 kPa. Ammonium, a product of the nitrogenase reaction, reversible inhibited nitrogenase activity when added to derepressed cell cultures. However, the inhibition of nitrogenase activity was only partial even with concentrations of ammonium chloride as high as 20 mM. Amides such as glutamine and asparagine partially inhibited nitrogenase activity, but glutamate did not. Nitrogenase in crude extracts prepared from ammonium-inhibited cells showed activity as high as in extracts from N_2-fixing cells. The pattern of the dinitrogenase and the dinitrogenase reductase revealed by the immunoblotting technique did not change upon ammonium chloride treatment of cells in vivo. No homologous sequences were detected with the draT-draG probe from Azospirillum lipoferum. There is no clear evidence that ADP-ribosylation of the dinitrogenase reductase is involved in the ammonium inhibition of H. seropedicae. The uncoupler carbonyl cyanide m-chlorophenylhydrazone decreased the intracellular ATP concentration and inhibited the nitrogenase activity of whole cells. The ATP pool was significantly disturbed when cultures were treated with ammonium in vivo.

29129 DNA sequence and regulation of the gene (cbpA) encoding the 42-kilodalton cytoplasmic membrane carotenoprotein of the cyanobacterium Synechococcus sp. strain PCC 7942. Reddy, K.J. (Univ. of Missouri-Columbia (USA)); Masamoto, K.; Sherman, D.M.; Sherman, L.A. *Journal of Bacteriology (USA)*, 171(6): 3486-3493 (Jun 1989). DOE Contract FG02-86ER13516.

The gene (cbpA) coding for a carotenoid-binding protein of the cyanobacterium Synechococcus sp. strain PCC 7942 (Anacystis nidulans R2) has been cloned and sequenced. A polyclonal antibody against the protein was used to identify immunoreactive clones from a λgt11 expression library of Synechococcus strain PCC 7942. The initial positive clone (λgtAN42) contained a 0.9-kilobase (kb) chromosomal fragment, which was used to detect a larger chromosomal fragment from a λEMBL3 library. The λEMBL3 recombinant, λEM109, contained an 18-kb portion of the Synechococcus strain PCC 7942 chromosome. The open reading frame of cbpA encoded 450 amino acids which give rise to a protein of 49,113 daltons. The hydrophobicity plot indicates that the protein may have a 49-residue signal sequence which is cleaved to yield a mature protein of 43,709 daltons. The protein has been localized in the cytoplasmic membrane by biochemical procedures as well as by electron microscopic immunocytochemistry. Northern (RNA) blot analysis indicates that transcription of cbpA is tightly regulated by DNA topology, light intensity, and iron concentration. Transcription is greatly induced by growth under high light intensities and repressed during growth under iron-deficient conditions. The DNA gyrase inhibitor novobiocin specifically inhibited the light-induced transcription. In Northern blots, the gene-specific probe hybridized to two size classes of RNA, with lengths of 2.0 and 6.2 kb. Since cbpA appears to be a component of the 6.2-kb transcript, it is likely part of a larger operon.

29130 Novel and remarkably thermostable ferredoxin from the hyperthermophilic archaebacterium Pyrococcus furiosus. Aono, S. (Univ. of Georgia, Athens (USA)); Bryant, F.O.; Adams,

M.W.W. *Journal of Bacteriology (USA)*, 171(6): 3433-3439 (Jun 1989). DOE Contract FG09-88ER13901.

The archaebacterium Pyrococcus furiosus is a strict anaerobe that grows optimally at 100°C by a fermentative-type metabolism in which H_2 and CO_2 are the only detectable products. A ferredoxin, which functions as the electron donor to the hydrogenase of this organism was purified under anaerobic reducing conditions. The study shows that P. furiosus ferredoxin is therefore distinct from other ferredoxins in that the bulk of its iron is not present as iron-sulfur clusters with an S = 1/2 ground state. The apoferredoxin was reconstituted with iron and sulfide to give a protein that was indistinguishable from the native ferredoxin by its iron content and electron paramagnetic resonance properties, which showed that the novel iron-sulfur clusters were not artifacts of purification. The reduced ferredoxin also functioned as an electron donor for H_2 evolution catalyzed by the hydrogenase of the mesophilic eubacterium Clostridium pasteurianum. P. furiosus ferredoxin was resistant to denaturation by sodium dodecyl sulfate (20%, wt/vol) and was remarkably thermostable. Its UV-visible absorption spectrum and electron carrier activity to P. furiosus hydrogenase were unaffected by a 12-h incubation at 95°C.

5503 Cytology

29131 (DOE/ER/25019–16) **The Sherman-Rinzel-Keizer model for bursting electrical activity in the pancreatic β-cell.** Pernarowski, M. (Washington Univ., Seattle, WA (USA). Dept. of Applied Mathematics); Kevorkian, J.; Miura, R.M. Washington Univ., Seattle, WA (USA). Dept. of Applied Mathematics. Mar 1990. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract FG06-86ER25019. Order Number DE90010423. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Pancreatic β-cells exhibit periodic bursting electrical activity (BEA) consisting of active and silent phases. The Sherman-Rinzel-Keizer (SRK) model of this phenomenon consists of three coupled first-order nonlinear differential equations which describe the dynamics of the membrane potential, the activation parameter for the voltage-gated potassium channel, and the intracellular calcium concentration. These equations are nondimensionalized and transformed into a Lienard differential equation coupled to a single first-order differential equation for the slowly changing nondimensional calcium concentration. Leading-order perturbation problems are derived for the silent and active phases of the BEA on slow and fast time scales. Numerical solutions of these leading-order problems are compared with those for the exact equation in their respective regions. The leading-order solution in the active phase has a limit cycle behavior with a slowly varying frequency. It is observed that the "damping term" in the Lienard equation is small numerically. 26 refs., 6 figs., 2 tabs.

5504 Genetics

Refer also to citation(s) 29115, 29146, 29164, 29890

29132 (AD-A–216496/0/XAB) **Design of oligonucleotides which attack specific gene targets. Annual report, December 1988-November 1989.** Hogan, M.E. Baylor Coll. of Medicine, The Woodlands, TX (USA). Center for Biotechnology. 8 Dec 1989. 19p. Available from NTIS, PC A03/MF A01.

During the first year of Navy support, we have refined our understanding of triple helix formation and in the process, have synthesized a set of triplex forming oligonucleotides directed against sites in the control region of interesting eukaryotic genes. We have shown that, in favorable instances, the dissociation constant for triplex formation can exceed 10-9M under physiological conditions. Work has begun to extend those structural analyses, by application of molecular modeling and 2D NMR methods. Work has also begun to apply photochemical analysis of triplex formation for the purpose of mapping triplex formation on gene target sites (HPRT and EGFR) within intact eukaryotic cells.

5505 Metabolism

Refer also to citation(s) 27426, 27810, 29256

29133 3H nuclear magnetic resonance study of anaerobic glycolysis in packed erythrocytes. Newmark, R.D. (Lawrence Berkeley Laboratory, CA (USA)); Un, S.; Williams, P.G.; Carson, P.J.; Morimoto, H.; Klein, M.P. *Proceedings of the National Academy of Sciences of the United States of America (USA)*, 87(2): 583-587 (Jan 1990).

The utility and power of 3H NMR spectroscopy as a technique for monitoring biological systems in vivo is illustrated with glucose metabolism in erythrocytes. Use of C-1-tritiated glucose allowed us to monitor the disappearance of the alpha and beta tritons, with the production of lactate and 1H3HO (HTO), as well as some intermediates. Spin lattice relaxation times (T1) were measured to avoid T1 distortion of the spectral intensities. Detection of the formation of 1 mM tritiated water in the presence of 110 M H2O protons and deuterons allows the eventual fate of the label in the pentose shunt to be observed in vivo.

29134 Modulation of alcohol dehydrogenase isoenzyme levels in zymomonas mobilis by iron and zinc. Mackenzie, K.F. (Univ. of Florida, Gainesville (USA)); Eddy, C.K.; Ingram, L.O. *Journal of Bacteriology (USA)*, 171(2): 1063-1067 (Feb 1989).

Zymomonas mobilis is an unusual microorganism which utilizes both iron-containing alcohol dehydrogenase (ADHII) and zinc-containing alcohol dehydrogenase (ADHI) isoenzymes during fermentative growth. This organism is obligately ethanologenic, and alcohol dehydrogenase activity is essential. The activities of ADHI and ADHII were altered by supplementing growth medium with iron or zinc salts and by iron starvation. Growth under iron-linking conditions (chelators, minimal medium) reduced ADHII activity but did not prevent the synthesis of the ADHII protein. The inactive form of this enzyme appeared quite stable, was not renatured by iron addition, and persisted in the cell. The iron-induced increase in ADHII activity required de novo synthesis which was blocked by antibiotic additions. The ability of Z. mobilis to synthesize ADHII and ADHI may be advantageous in nature.

5506 Medicine

Refer also to citation(s) 28557

29135 (FNAL-TM–1656) **Technical assessment of the Loma Linda University proton therapy accelerator.** Fermi National Accelerator Lab., Batavia, IL (USA). Oct 1989. 124p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE90008184. Available from NTIS, PC A06/MF A01; OSTI; INIS.

In April 1986, officials of Loma Linda University requested that Fermilab design and construct a 250 MeV proton synchrotron for radiotherapy, to be located at the Loma Linda University Medical Center. In June 1986 the project, having received all necessary approvals, commenced. In order to meet a desirable schedule providing for operation in early 1990, it was decided to erect such parts of the accelerator as were complete at Fermilab and conduct a precommissioning activity prior to the completion of the building at Loma Linda which will house the final radiotherapy facility. It was hoped that approximately one year would be saved by the precommissioning, and that important information would be obtained about the system so that improvements could be made during installation at Loma Linda. This report contains an analysis by Fermilab staff members of the information gained in the precommissioning activity and makes recommendations about steps to be taken to enhance the performance of the proton synchrotron at Loma Linda. In the design of the accelerator, effort was made to employ commercially available components, or to industrialize the products developed so that later versions of the accelerator could be produced industrially. The magnets could only be fabricated at Fermilab if the schedule was to be met, but efforts were made to transfer that technology to industry. Originally, it was planned to use a 1.7 MeV RFQ fabricated at the Lawrence Berkeley Laboratory as injector, but LBL would have found it difficult to meet the project schedule. After consideration of other options, for example a 3.4 MeV tandem accelerator, a supplier (AccSys Inc.) qualified itself to provide a 2 MeV RFQ on a schedule well matched to the project schedule. This choice was made, but a separate supplier was selected to develop and provide the 425 MHz power amplifier for the RFQ.

29136 (KEK–89-5, pp. 92-98) **Acoustic signal generation in excised muscle by pulsed proton beam irradiation and the possibility of its clinical application to radiation therapy.** Hayakawa, Yoshinori (Tsukuba Univ., Ibaraki (Japan). Inst. of Basic Medical Science); Tada, Junichiro; Inada, Tetsuo; Kitagawa, Toshio; Wagai, Toshio; Yoshioka, Katsuya. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jul 1989. (CONF-8901176–: 4. workshop on radiation detectors and their uses, Tsukuba (Japan), 24-25 Jan 1989). In *Radiation detectors and their uses.* Order Number DE90741444. Available from NTIS (US Sales Only), PC A08/MF A01.

Acoustic signals generated in liquids and in metals by pulsed proton beam are thought to be thermal shock wave due to localized energy deposition of incident protons. Thus the intensity of generated acoustic signals is almost proportional to the energy deposited at the region. This suggests the possibility for measuring spatial distribution of energy deposition of proton beam using the acoustic method. In proton beam radiation therapy, treatment planning is developed from data of X-ray computer tomography which reflects the information on the electron density distribution in the patient's body. Ensuring the agreement of the dose distribution in the patient with the planned one, however, is difficult. It is expected that the acoustic method can provide a useful tool for this purpose. The pulsed proton beam of 50ns in pulse width is used for cancer therapy at the University of Tsukuba. A hydrophone is used to detect acoustic signals generated by pulsed proton beam. Detected signals are amplified ten thousand times before being averaged and analyzed by digital oscilloscope. Measurements made suggest that the method could be useful for radiation therapy. (N.K.).

29137 (NAC-AR–86-01, pp. 165-167) **Particle therapy: Neutron therapy.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

The installation of the isocentric neutron therapy system was completed during the second half of 1985. Final commissioning is currently scheduled to commence in July 1986. 1 fig., 3 refs.

29138 (NAC-AR–86-01, pp. 166) **Particle therapy: Proton therapy.** . National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Short note. PROTON RADIOGRAPHY; NAC CYCLOTRON; PROGRESS REPORT; PROTON BEAMS

29139 (NAC-AR–86-01, pp. 176-180) **The Pretoria cyclotron facility: Radiation physics.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Intercomparison measurements were performed at the MRC Cyclotron, Clatterbridge (U.K.). Discrepancies between the previously stated doses of Hammersmith Hospital, London and the doses measured at NAC (Pretoria) have been resolved with the introduction of a simple correction factor. Spectral energy measurements have been performed in air at SSD and in-phantom for the neutron therapy beam. The average energy E_n of the in-air spectrum together with values for the average kerma ratio $(K_l/K_m)_N$ and the ratio of the average energies required to create an ion pair in the A150/TE gas ionization chamber were determined. Cognizance regarding radiation protection measures has been taken concerning recent ICRP recommendations doubling the quality factor for fast neutrons. Modifications to the safety interlock system of the neutron therapy facility were implemented to allow for the independent use of the kilocurie ^{60}Co radiation unit. 2 figs., 13 refs.

29140 (NAC-AR–86-01, pp. 228) **Nuclear analytical chemistry: Applications in medicine.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Short note. NUCLEAR MEDICINE/multi-element analysis; ABSORPTION SPECTROSCOPY; BLOOD SERUM; COPPER; INFANTS; NAC CYCLOTRON; PIXE ANALYSIS; PROGRESS REPORT; TRACE AMOUNTS; WOMEN; ZINC

29141 (NAC-AR–86-01, pp. 246-250) **Biophysical sciences.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

One of the objectives of the National Accelerator Centre is to provide facilities for radiotherapy of cancer patients. It is therefore logical that some scientific effort be directed at the underlying molecular mechanisms involved in carcinogenesis and the effectiveness of particle irradiation on cell survival.

29142 (ORNL/TM–11427) **Nuclear Medicine Program progress report for quarter ending December 31, 1989.** Knapp, F.F. Jr.; Ambrose, K.R.; Callahan, A.P.; McPherson, D.W.; Mirzadeh, S.; Srivastava, P.C.; Allred, J.F.; Hasan, A.; Lambert, C.R.; Lambert, S.J. Oak Ridge National Lab., TN (USA). Apr 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010249. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this report the use of a simple colorimetric assay employing the bisthiosemicarbazone (TSC) derivative of phenylglyoxal to evaluate the specific activity of spallation-produced copper-67 (Cu-67) samples is described. Four samples from the Los Alamos National Laboratory (LANL) and one sample from the Brookhaven National Laboratory (BNL) were analyzed and the results compared in a "blind study" with specific activity values obtained by isotope coupling plasma (ICP) analysis at the production sites. A good comparison was found, and these results indicate that the TSC approach is a simple, inexpensive, and rapid technique to determine the specific activity of spallation-produced Cu-67. The synthesis, radioiodination, and evaluation of deiodination in rats in vivo of two new maleimide agents for antibody labeling is also described. 3 figs., 1 tab.

29143 Comparison of different radiation types and irradiation geometries in stereotactic radiosurgery. Phillips, M.H. (Lawrence Berkeley Laboratory, CA (USA)); Frankel, K.A.; Lyman, J.T.; Fabrikant, J.I.; Levy, R.P. *International Journal of Radiation Oncology, Biology and Physics (USA),* 18(1): 211-220 (Jan 1990).

Recent interest in stereotactic radiosurgery of intracranial lesions, and the development of stereotactic irradiation techniques has led to the need for a systematic and complete comparison of these methods. A method for conducting these comparisons is proposed and is applied to a set of currently-used stereotactic radiosurgical techniques. Three-dimensional treatment planning calculations are used to compare dose distributions for several different radiation types and irradiation geometries. Calculations were performed using charged particles (H, He, C, and Ne ions) and the irradiation geometry currently used at Lawrence Berkeley Laboratory. Photons in the Gamma Knife configuration and the Heidelberg Linac arc method are used. The 3-dimensional dose distributions were evaluated by means of dose-volume histograms and integral doses to the target volume and to normal brain. The effects of target volume, shape and location are studied. The charged particle dose distributions are more favorable than those of the photon methods. The differences between charged particles and photons increase with increasing target volume. The differences between different charged particle species are small, as are the effects of target shape and location.

29144 No-carrier-added [1^{11}C]putrescine. McPherson, D.W.; Fowler, J.S.; Wolf, A.P. To Dept. of Energy, Washington, DC. USA Patent 4874600/A/. 17 Oct 1989. Filed date 17 Apr 1986. USA Patent Application 6-853,105. Int. Cl. A61J 49/02. 6p.

This paper describes a radiolabeled imaging agent, no-carrier-added [1^{11}C]putrescine, and the use of this very pure material as a radiotracer with positron emission tomography for imaging brain tumors. The invention relates to the synthesis of no-carrier-added [1^{11}C]putrescine based on the Michael addition of potassium ^{11}C-labeled dinitrile. The method is rapid and efficient and provides radiotracer with a specific activity greater than 1.4 curies per millimol and in a purity greater than 95%.

5507 Microbiology

Refer also to citation(s) 27425, 27426, 27809, 27811, 28966

29145 (DOE/ER/60842–1) **Factors affecting transport of bacterial cells in porous media: Technical progress report.** Mills, A.L.; Herman, J.S.; Hornberger, G.M. Virginia Univ., Charlottesville, VA (USA). Dept. of Environmental Sciences. Mar 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-89ER60842. Order Number DE90009314. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

There are serious deficiencies in our fundamental knowledge of biogeochemical processes associated with the growth and transport of free-living bacteria in geological media. This project utilizes a series of controlled and replicated laboratory experiments to examine and quantify factors influencing the growth and penetration of bacteria in a porous medium. The experimental design is based on response surface methods and investigates the effects of surface chemistry, grain size, bacterial shape and size, motility, propensity for aggregation, solution chemistry and flow characteristics on transport of the bacteria. Auxiliary experiments examine adsorption reactions and other individual responses that may be poorly understood. We have thus far conducted experiments dealing with the breakthrough of bacteria in columns of clean quartz sand and iron oxyhydroxide-coated quartz sand, experiments dealing with the transport of bacteria through porous media containing preferred flow paths, experiments concerning the effect of bacterial cell size on transport and experiments on the effect of the ionic strength of the solution on bacterial transport. Additionally we have begun to evaluate the tendency for free-living vs particle-attached bacteria from deep and shallow subsurface environments to adhere to mineral surfaces due to hydrophobic properties of the cell exterior. This report summarizes the accomplishments and findings of our work to date. 5 figs., 1 tab.

29146 (ORNL–6614) **Conventionally altered organisms: Database on survival, dispersal, fate, and pathogenicity.** Kuklinski, D.M.; King, K.H.; Addison, J.T.; Travis, C.C. Oak Ridge National Lab., TN (USA). 29 Mar 1990. 135p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90010214. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

Although increases in development and sales of biotechnology are projected, research on the risks associated with deliberate releases of biotechnology products lags behind. Thus, there is an urgent need to provide investigators and regulators with guidelines for classifying and evaluating risks associated with the release of genetically engineered microorganisms (GEMs). If the release of GEMs into the environmental poses risks similar to that of releasing conventionally altered organisms (CAOs), then a study evaluating the hazards associated with environmentally released CAOs would be most useful. This paper provides a survey of the available data on survival, dispersal, pathogenicity, and other characteristics which affect the fate of microbes after release. Although the present study is not exhaustive, it does provide an indication of the type and amount of data available on CAOs. 350 refs.

5509 Pathology

Refer also to citation(s) 27845

5510 Physiological Systems

Refer also to citation(s) 29258

29147 (CCOFI–90009969) **California Cooperative Oceanic Fisheries Investigations Reports: Volume 30, January 1 to December 31, 1988.** Olfe, J.; Lang, C.; Vernet, M. (eds.). California Dept. of Fish and Game, Long Beach, CA (USA); Scripps Institution of Oceanography, La Jolla, CA (USA); National Marine Fisheries Service, La Jolla, CA (USA). Oct 1989. 151p. Available from CalCOFI, California Department of Fish and Game, 330 Golden Shore, Suite 50, Long Beach, CA 90802.

Includes index for 1983–1988.

This document contains 15 papers. Topics include a review of some California fisheries, spawning biomass of the northern anchovy, marine fisheries, habitat alterations, fishery management, reproduction, population dynamics, acoustic Doppler currents and sea lion interaction and depredation. Each paper will be indexed and entered separately on the energy data base. 54 figs., 29 tabs. (KD)

29148 Evidence from Solanum tuberosum in support of the dual-pathway hypothesis of aromatic biosynthesis. Morris, P.F. (Univ. of Florida, Gainesville (USA)); Doong, R.L.; Jensen, R.A. *Plant Physiology (USA)*, 89(1): 10-14 (Jan 1989). DOE Contract FG05-86ER13581.

Key branchpoint enzymes of aromatic amino acid biosynthesis, 3-deoxy-D-arabino-heptulosonate 7-phosphate synthase (DS) and chorismate mutase (CM), have previously been shown to exist as separate compartmentalized isozymes in the chloroplasts and cytosol of tobacco, sorghum and spinach. Although additional examples of plants containing these isozyme pairs are accumulating, some studies in the literature report the presence of only the single plastidic DS or CM enzyme. Such apparent exceptions contradict the universality of pathway organization existing in higher plants that is implied by the dual-pathway hypothesis of aromatic biosynthesis. Since potato (Solanum tuberosum) exemplifies a case where only a single species of both DS and CM have been reported, we selected this system for further analysis. The DS-Mn and DS-Co isozyme pair, exhibiting all of the differential properties described in Nicotiana silvestris, have now been identified in S. tuberosum. Likwise, partial purification via DEAE-cellulose chromatography revealed two isozymes of CM in disks excised from tubers of S. tuberosum. The differential regulatory properties of these isozymes were comparable to the CM-1 and CM-2 isozymes of N. silvestris.

29149 Intestinal uptake of fluorescent microspheres in young and aged mice (42825). LeFevre, M.E. (Brookhaven National Laboratory, Upton, NY (USA)); Boccio, A.M.; Joel, D.D. *Proceedings of the Society for Experimental Biology and Medicine (USA)*, 190(1): 23-27 (1989).

Rhodamine B-labeled synthetic latex particles (microspheres), 1.8 μm in diameter, were administered by gavage 5 days per week to young (24 days) and aged (18 months) mice. After 25 days (19 gavages), the particles were assayed in solubilized tissues by depositing them of filters and counting under fluorescence microscopy. Aged mice exhibited significantly more fluorescent particle accumulation in Peyer's patches but significantly less in lungs than young mice. Mesenteric lymph nodes and Peyer's patch-free intestinal segments contained measurable latex, but differences between young and aged animals were not significant. Liver contained only trace amounts of latex, and spleen and kidney were latex free in both young and aged animals. Nonquantitative observations on KOH-glycerol-cleared whole Peyer's patches and slices of liver, lung, and mesenteric lymph node were similar.

29150 Effect of water stress on chlorophyll and carotenoid contents on seedlings from three seed sources of Pinus ponderosa. Benes, S.E. (Lawrence Livermore National Lab., CA (USA)); Houpis, J.L.J. *Plant Physiology, Supplement (USA)*, 89(4): 124 (Apr 1989).

The effect of water stress on pigmentation was studied on seedlings from three seed sources of ponderosa pine (Pinus ponderosa Dougl.) selected from similar latitudes but along a gradient of decreasing water availability from the California coast to the western and eastern sides of the Sierra Nevada Mountains. All plants were grown in a common garden for 18 months. Water was withheld from the two-year old potted seedlings and weekly needle samples were taken for the 10 week drought period and for a two week recovery period. Pigments were passively extracted in dimethylformamide and quantified spectrophotometrically. The seedlings from the more mesic seed zone exhibited water stress earlier (Week 8) and to a greater extent (-1.53 Mpa predawn water potential) than seedlings from the other two seed zones. However, chlorophyll and carotenoid concentrations did not correspond to increasing level of water stress. There were differences in pigmentation among the seedlings from the three seed zones, with those seedlings from the west side of the Sierra Nevada having less chlorophyll a and b, and carotenoids than those from the other two regions. Analysis of the chlorophyll a and b, and carotenoids than those from the other two regions. Analysis of the chlorophyll a/b ratio indicated that although there were differences in pigmentation, the relative abundance of chlorophyll a to be was consistent among seedlings from all three seed zones.

29151 Comparative biochemistry of betaine biosynthesis and accumulation in diverse dicot families. McCue, K.F. (Michigan State Univ., East Lansing (USA)); Weretilnyk, E.A.; Bednarek, S.Y.; Hanson, A.D. *Plant Physiology, Supplement (USA),* 89(4): 125 (Apr 1989).

Salt stress elicits betaine accumulation to high levels in species from several diverse dicot families (Chenopodiaceae, Amaranthaceae, Convolvulaceae, Solanaceae, and Asteraceae). FAM-MS studies with deuterated precursors showed that species from all these families synthesize betaine from choline. Enzyme assays and immunotitration data showed that all accumulating species contained betaine aldehyde dehydrogenase (BADH) enzyme activity recognized by antibodies raised against purified BADH isolated from Spinacia oleracea. Immunoblotting indicated that the BADH monomer was in all cases of Mr ≈ 63,000. The similarity of BADH in the different species is consistent with a single evolutionary origin for the betaine pathway. This was supported by the presence in immunoblots of a cross-reacting band at Mr ≈ 63,000 in Magnolia x Soulangiana, a primitive angiosperm.

29152 Physiological indicators of nitrogen response in short-rotation sycamore plantations. Tschaplinski, T.J. (Oak Ridge National Lab., TN (USA)); Norby, R.J. *Plant Physiology, Supplement (USA),* 89(4): 126 (Apr 1989).

American sycamore (Platanus occidentalis L.) seedlings were grown in the field under urea-nitrogen fertilization regimes to identify physiological variables that characterize the growth responses. Treatments included trees fertilized at the beginning of the growing season with 450 kg N/ha, trees fertilized periodically (three times during the growing season) at 37.5 kg N/ha, and unfertilized controls. Above ground biomass accumulation in the heaviest nitrogen treatment was three times that of the controls, and nearly as much growth occurred when less nitrogen was added periodically. Photosynthesis, chlorophyll concentrations, and growth increased rapidly after a midseason application of a small amount of nitrogen, but not to a late-season application. There was no evidence that fertilization extended the physiologically active season or increased susceptibility to drought or cold. Sycamore leaves accumulated sucrose and mannose in response to water and cold stress in all treatments. Photosynthetic pigment concentrations, net photosynthetic rate, and leaf nitrate reductase activity were sensitive indicators of nitrogen fertilization, but foliar concentrations of nitrate, total nitrogen, soluble carbohydrate and soluble protein were not.

29153 Isolation of Arabidopsis mutants with altered seed fatty acid composition. Lemieux, B. (Dept. of Energy, East Lansing, MI (USA)); Browse, J.; Somerville, C. *Plant Physiology, Supplement (USA),* 89(4): 130 (Apr 1989).

By direct screening of Arabidopsis seed fatty acid methyl esters, we have isolated mutants which are deficient in the elongation of 18:1 to 20:1 and the desaturation of 18:2 to 18:3. Both the elongation and the desaturation mutants, designated MB14 and BL1 respectively, have only 10% of the wild-type levels of 20:1 and 18:3 in their seeds. The intermediate levels of 20:1 and 18:3 in F1 seeds of crosses to the wild type indicate that the level of enzyme is regulating the amount of 20:1 and 18:3 in seeds. Consistent with this observation, the mutations were found to segregate 1:2:1 in F2 seeds. We have found that the 18:2 desaturase mutation is clearly expressed in root phosphatidylcholine.

29154 Oligogalacturonides induce flowers in tobacco thin cell layers. Marfa-Riera, V. (Univ. of Georgia, Athens (USA)); Gollin, D.; Mohnen, D.; Darvill, A.; Albersheim, P. *Plant Physiology, Supplement (USA),* 89(4): 141 (Apr 1989).

An optimized tobacco thin-cell-layer (TCL) bioassay was used to study the induction of flowers by plant oligosaccharins. Endopolygalacturonase (EPG)-released fragments of suspension-cultured sycamore cell walls induced flowers on TCLs grown on a medium containing 1.5 μM IBA and 0.9 μM kinetin. The EPG-released fragments were primarily composed of the polysaccharides rhamnogalacturonan I (RG-I), rhamnogalacturonan II (RG-II), and α-1,4-linked oligogalacturonides. The α-1,4-linked oligogalacturonides, subsequently purified from the EPG-released sycamore cell wall fragment mixture, induced flowers on TCLs. Purified RG-I and RG-II did not induce flowers. Oligosaccharide fragments, generated by partial acid hydrolysis of citrus pectin, were also capable of inducing flowers on the TCLs. The active components in the pectin fragment mixture were α-1,4-linked oligogalacturonides. Oligogalacturonides with a degree of polymerization (DP) of 8-16, at concentrations of ≈ 0.1 μM, induced flowers, while oligogalacturonides with a DP 2-7, even at higher concentrations, did not. Oligogalacturonides have previously been shown to induce the synthesis of phytoalexins, protease inhibitors, lignin, and ethylene in other plant systems. Thus, the ability of α-1,4-linked oligogalacturonides to induce flower formation in the tobacco TCLs represents a new biological activity of these oligosaccharins.

29155 Tissue printing on nitrocellulose membrane. Taylor, R. (Washington Univ., St. Louis, MO (USA)); Song, Yanru; Pont-Lezica, R.; Lin, Liangshiou; Ye, Zhenghua; Varner, J.E. *Plant Physiology, Supplement (USA),* 89(4): 141 (Apr 1989).

In the 1950's Daoust developed substrate film printing on gelatin and starch films to localize protease, amylase, DNAase and RNAase activities. These procedures were adapted to plant tissues by Yomo and Taylor (1973) and by Jacobsen and Knox (1973). Membranes such as nitrocellulose bind cellular materials from cut tissue surfaces with little lateral diffusion. Thus accurate chemical prints are obtained. When the tissue is pressed firmly onto nitrocellulose a physical impression is obtained which shows the anatomy of the tissue. We have used the tissue-print technique to localize (1) proteins with labeled antibodies, (2) RNA with labeled nucleic acid probes, (3) enzymes by catalytic activity, (4) glycoproteins by fluorescent lectins, (5) lectins by fluorescent sugars, (6) cysteine-rich proteins by dansylated iodoacetamide, (7) ascorbic acid by silver nitrate, (8) soluble fluorescent compounds by direct observation.

29156 Monoclonal antibodies against plant cell wall polysaccharides. Hahn, M.G. (Univ. of Georgia, Athens (USA)); Bucheli, E.; Darvill, A.; Albersheim, P. *Plant Physiology, Supplement (USA),* 89(4): 141 (Apr 1989).

Monoclonal antibodies (McAbs) are useful tools to probe the structure of plant cell wall polysaccharides and to localize these polysaccharides in plant cells and tissues. Murine McAbs were generated against the pectic polysaccharide, rhamnogalacturonan I (RG-I), isolated from suspension-cultured sycamore cells. The McAbs that were obtained were grouped into three classes based upon their reactivities with a variety of plant polysaccharides and membrane glycoproteins. Eleven McAbs (Class I) recognize epitope(s) that appear to be immunodominant and are found in RG-I from sycamore and maize, citrus pectin, polygalacturonic acid, and membrane glycoproteins from suspension-cultured cells of sycamore, maize, tobacco, parsley, and soybean. A second group of five McAbs (Class II) recognize epitope(s) present in sycamore RG-I, but do not bind to any of the other polysaccharides or glycoproteins recognized by Class I. Lastly, one McAb (Class III) reacts with sycamore RG-I, sycamore and tamarind xyloglucan, and sycamore and rice glucuronoarabinoxylan, but does not bind to maize RG-I, polygalacturonic acid or the plant membrane glycoproteins recognized by Class I. McAbs in Classes II and III are likely to be useful in studies of the structure, biosynthesis and localization of plant cell wall polysaccharides.

29157 Inhibition of foliar gas exchange by ethylene is an ultrasensitive response. Gunderson, C.A. (Oak Ridge National Lab., TN (USA)); Taylor, G.E. Jr. *Plant Physiology, Supplement (USA),* 89(4): 162 (Apr 1989).

The inhibition of foliar gas exchange as a function of ethylene (C_2H_4) concentration was examined to evaluate the potential role of C_2H_4 in mediating gas exchange responses to environmental stress. Net photosynthesis (P_N) and stomatal conductance to H_2O vapor (g_t) were measured in soybean (Glycine max) seedlings after a 4 h exposure to C_2H_4 (0-20 $\mu l\ l^{-1}$) in a controlled environment system. Continuous steady-state measurements of leaflets held at a constant angle to incident light confirmed the magnitude of the maximal response and the time course of response. The declines in gas exchange showed saturation, with half-maximal response at 0.15 $\mu l\ l^{-1}$ for g_s and 0.35 $\mu l\ l^{-1}$ for P_N. Concentration-response curves for both functions were similar to those reported for C_2H_4 binding (in vivo and in vitro) and for hormonally mediated C_2H_4 actions. Kinetic analyses of the saturation patterns using the Hill equation showed both responses to be ultrasensitive, i.e., provide

a relatively large change in gas exchange for a small change in C_2H_4 concentration. The patterns of inhibition of g_s and P_N and the ultrasensitivity of both responses suggest a role for endogenously produced stress C_2H_4 in mediating the responsiveness of foliar gas exchange to many environmental stresses.

29158 Enhanced symbiotic nitrogen fixation with P. syringae pv tabaci. Langston-Unkefer, P.J. (Los Alamos National Lab., NM (USA)); Knight, T.J.; Sengupta-Gopalan, C. *Plant Physiology, Supplement (USA),* 89(4): 179 (Apr 1989).

Infestation of legumes such as alfalfa and soybeans with the plant pathogen Pseudomonas syringae pv. tabaci is accompanied by increased plant growth, nodulation, overall nitrogen fixation, and total assimilated nitrogen. These effects are observed only in plants infested with Tox^+ pathogen; the toxin is tabtoxinine-β-lactam, an active site-directed irreversible inhibitor of glutamine synthetase. The key to the legumes survival of this treatment is the insensitivity of the nodule-specific form of glutamine synthetase to the toxin. As expected, significant changes are observed in ammonia assimilation in these plants. The biochemical and molecular biological consequences of this treatment are being investigated.

29159 Characterization of inositol phosphates in carrot (Daucus carota L.) cells. Rincon, M. (North Carolina State Univ., Raleigh (USA)); Chen, Q.; Boss, W.F. *Plant Physiology (USA),* 89(1): 126-132 (Jan 1989). DOE Contract FG05-87ER13693.

We have shown previously that inositol-1,4,5-trisphosphate (IP_3) stimulates an efflux of $^{45}Ca^{2+}$ from fusogenic carrot protoplasts. In light of these results, we suggested that IP_3 might serve as a second messenger for the mobilization of intracellular Ca^{2+} in higher plant cells. To determine whether or not IP_3 and other inositol phosphates were present in the carrot cells, the cells were labeled with myo-[2-^{3}H]inositol for 18 hours and extracted with ice-cold 10% trichloroacetic acid. The inositol metabolites were separated by anion exchange chromatography and by paper electrophoresis. We found that [^{3}H]inositol metabolites coeluted with inositol bisphosphate (IP_2) and IP_3 when separated by anion exchange chromatography. However, we could not detect IP_2 or IP_3 when the inositol metabolites were analyzed by paper electrophoresis even though the polyphosphoinositides, which are the source of IP_2 and IP_3, were present in these cells. Thus, [^{3}H]inositol metabolites other than IP_2 and IP_3 had coeluted on the anion exchange columns. The data indicate that either IP_3 is rapidly metabolized or that it is not present at a detectable level in the carrot cells.

29160 A developmentally regulated hydroxyproline-rich glycoprotein in maize pericarp cell walls. Hood, E.E. (Washington Univ., St. Louis, MO (USA)); Shen, Q.X.; Varner, J.E. *Plant Physiology (USA),* 87(1): 138-142 (May 1988). DOE Contract FG02-84ER13255.

We have studied the accumulation of peptidyl hydroxyproline in the pericarp of developing maize (Zea mays L., Golden cross Bantam sweet corn) kernels. Although this hydroxyproline accumulates throughout development, it is most soluble and its content per milligram dry weight greatest at midmaturation stages of development. Salt-soluble proteins containing this hydroxyproline from isolated cell walls of developing kernels were fractionated on a CsCl density gradient and on a Chromatofocusing column, resulting in the purification of an hydroxyproline-rich glycoprotein, PC-1. PC-1 is a basic protein of approximately 65 to 70 kilodaltons in molecular weight with an isoelectric point of at least 10.2 and a density of 1.38 to 1.39 in CsCl. Amino acid composition data indicate that it is rich in hydroxyproline, threonine, proline, lysine, and glycine. Its relation to dicot extension is discussed.

29161 Acclimation of photosynthesis to elevated CO_2 in five C_3 species. Sage, R.F. (Univ. of Georgia, Athens (USA)); Sharkey, T.D.; Seemann, J.R. *Plant Physiology (USA),* 89(2): 590-596 (Feb 1989). DOE Contract FG08-84ER13234.

The effect of long-term (weeks to months) CO_2 enhancement on (a) the gas-exchange characteristics, (b) the content and activation state of ribulose-1,5-bisphosphate carboxylase (rubisco), and (c) leaf nitrogen, chlorophyll, and dry weight per area were studied in five C_3 species (Chenopodium album, Phaseolus vulgaris, Solanum tuberosum, Solanum melongena, and Brassica oleracea) grown at CO_2 partial pressures of 300 or 900 to 1000 microbars. Long-term exposure to elevated CO_2 affected the CO_2 response of photosynthesis in one of three ways: (a) the initial slope of the CO_2 response was unaffected, but the photosynthetic rate at high CO_2 increased (S. tuberosum); (b) the initial slope decreased but the CO_2-saturated rate of photosynthesis decreased (B. oleracea, S. melongena). In all five species, growth at high CO_2 increased the extent to which photosynthesis was stimulated following a decrease in the partial pressure of O_2 or an increase in measurement CO_2 above 600 microbars. This stimulation indicates that a limitation on photosynthesis by the capacity to regenerate orthophosphate was reduced or absent after acclimation to high CO_2. Leaf nitrogen per area either increased (S. tuberosum, S. melongena) or was little changed by CO_2 enhancement. The content of rubisco was lower in only two of the fives species, yet its activation state was 19% to 48% lower in all five species following long-term exposure to high CO_2. These results indicate that during growth in CO_2-enriched air, leaf rubisco content remains in excess of that required to support the observed photosynthetic rates.

29162 Isolation and characterization of a starchless mutant of Arabidopsis thaliana (L.) Heynh lacking ADPglucose pyrophosphorylase activity. Lin, Tsanpiao (Michigan State Univ., East Lansing (USA)); Caspar, T.; Somerville, C.; Preiss, J. *Plant Physiology (USA),* 86(4): 1131-1135 (Apr 1988). DOE Contract AC02-76ER01338.

A mutant of Arabidopsis thaliana lacking ADPglucose pyrophosphorylase activity (EC 2.7.7.27) was isolated (from a mutagenized population of plants) by screening for the absence of leaf starch. The mutant grows as vigorously as the wild type in continuous light but more slowly than the wild type in a 12 hours light/12 hours dark photoperiod. Genetic analysis showed that the deficiency of both starch and ADPglucose pyrophosphorylase activity were attributable to a single, nuclear, recessive mutation at a locus designated adg1. The absence of starch in the mutant demonstrates that starch synthesis in the chloroplast is entirely dependent on a pathway involving ADPglucose pyrophosphorylase. Analysis of leaf extracts by two-dimensional polyacrylamide gel electrophoresis followed by Western blotting experiments using antibodies specific for spinach ADPglucose pyrophosphorylase showed that two proteins, present in the wild type, were absent from the mutant. The heterozygous F_1 progeny of a cross between the mutant and wild type had a specific activity of ADP-glucose pyrophosphorylase indistinguishable from the wild type. These observations suggest that the mutation in the adg1 gene in TL25 might affect a regulatory locus.

29163 Role of motility and chemotaxis in efficiency of nodulation by Rhizobium meliloti. Caetano-Anolles, G. (Universidad Nacional de la Plata (Argentina)); Wall, L.G.; De Micheli, A.T.; Macchi, E.M.; Bauer, W.D.; Favelukes, G. *Plant Physiology (USA),* 86(4): 1228-1235 (Apr 1988). DOE Contract FG02-84ER13211.

Spontaneous mutants of Rhizobium meliloti L5-30 defective in motility or chemotaxis were isolated and compared against the parent with respect to symbiotic competence. Each of the mutants were able to generate normal nodules on the host plant alfalfa (Medicago sativa), but had slightly delayed nodule formation, diminished nodulation int he initially susceptible region of the host root, and relatively low representation in nodules following coinoculation with equal numbers of the parent. When inoculated in growth pouches with increasing dosages of the parental strain, the number of nodules formed in the initially susceptible region of the root increased sigmoidally, with an optimum concentration of about 10^5 to 10^6 bacteria/plant. The dose-response behavior of the nonmotile and nonchemotactic mutants was similar, but they required 10- to 30-fold higher concentrations of bacteria to generate the same number of nodules. The distribution frequencies of nodules at different positions along the primary root were very similar for the mutants and parent, indicating that reduced nodulation by the mutants in dose-response experiments probably reflects reduced efficiency of nodule initiation rather than developmentally delayed nodule initiation. The number of bacteria that firmly adsorbed to the host root surface during several hours of incubation was 5- to 20-fold greater for the parent than the mutants.

5520 Public Health

Refer also to citation(s) 27835, 28916, 29035

5530 Agriculture and Food Technology

Refer also to citation(s) 27795, 27838, 27850, 29196, 29197

29164 (DOE/ER/13900–2) **[Structure and expression of nuclear genes encoding rubisco activase]: Progress report.** Zielinski, R.E. Illinois Univ., Urbana, IL (USA). Dept. of Plant Biology. [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER13900. Order Number DE90009310. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Our activities during the past year have centered around two basic aspects of the project: describing more thoroughly the diurnal and light irradiance effects on activase gene expression in barley; and isolating and structurally characterizing cDNA and genomic DNA sequences encoding activase from barley. Three appendices are included that summarize these activities.

29165 (EGG-CEMA–8924) **Assessment of federal databases to evaluate agroecosystem productivity.** Olson, G.L.; Breckenridge, R.P.; Wiersma, G.B. EG and G Idaho, Inc., Idaho Falls, ID (USA). Center for Environmental Monitoring and Assessment. Feb 1990. 39p. Sponsored by Environmental Protection Agency. DOE Contract AC07-76ID01570. Order Number DE90009609. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Ecological monitoring data that could provide indications of agroecosystem condition, such as soil microbial biomass, biodiversity in the patches or mineralizable-N, are not available on a national scale. This paper discusses the economists' and ecologists' approach to assessing agroecosystem productivity, and the data available to make ecological assessments of agroecosystems on a national level. Models and indices of productivity used by ecologists and economists are briefly discussed in the context of agricultural inputs and outputs. Databases on production, pesticides, fertilizers, water use, water and air quality, land use, soil, labor and machinery are evaluated for their ability to make national trend assessments on how this ecosystem responds to stress. 39 refs., 3 figs., 3 tabs.

29166 (JAERI-M–89-197) **Sprout inhibition and change in organic components of potato by gamma-irradiation.** Rahman, M.S. (Institute of Food and Radiation Biology, Dacca (Bangladesh)); Kume, Tamikazu; Ishigaki, Isao. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 18p. Order Number DE90777721. Available from NTIS (US Sales Only), PC A03/MF A01.

Radiation technology for sprout inhibition and change in organic components of potato by irradiation were investigated. Dose distribution in the package filled with potatoes (depth 45cm, density: 0.56g/cm^3) was measured using Fricke dosimeter. When the package was irradiated at dose rate of 5 x 10^5, 1 x 10^5 and 5 x 10^4 rad/hr, the dose uniformities were calculated as 1.79, 1,45 and 1.35, and the relative throughput capacities were 1.0, 0.26 and 0.14, respectively. After 7 months storage, the sprout of potatoes was not observed at 10 krad irradiation while 57% of potatoes was sprouted at 5 krad. The contents of oxalic and malic acids were slightly increased by irradiation up to 100 krad while that of citric and succinic acids were not changed. The change in contents of these organic acids during storage was almost the same in both unirradiated and irradiated samples. Sucrose content was reached maximum after 8 days in 15 krad irradiated sample while it was increased through 40 days storage in 300 krad irradiated sample. The increase in sucrose contents by irradiation was higher in cortical tissue than in medullary tissue. (author).

29167 (SLU-IMB–40, pp. 152-155) **Cleaning of waste water from a mink fodder factory - an example of a mobile anaerobic filter.** Hagelberg, M. (Bioenergi AB, Ludvika (SE)); Lindow, L. Swedish Univ. of Agriculture, Uppsala (Sweden). Dept. of Microbiology. 1989. (In Swedish). (CONF-8812133–: Conference on the biogas process in the Nordic countries: research and application, Uppsala (Sweden), 6-7 Dec 1988). In *The biogas process in the Nordic countries. Research and Application.* Order Number DE90770812. Available from NTIS (US Sales Only), PC A09/MF A01.

The production volume of fodder for minks varies within a year with peaks during the 4-5 months long period of birthgiving. The fodder is mainly prepared from fish, blood from slaughterhouses and fat. The waste water from the production gives rise to COD of 7-30 g l^{-1}, heavy concentration of suspended solids and a pH between 4.5 and 6. The water flow is around 40 m^3 a day, from which a part is used to test a treatment equipment. The waste water treatment plant is composed of three parts: separation of suspended solids, an 8 m^3 anaerobic filter and a 6 m^3 bio tower in series. After the separation step for solids the COD was reduced to ca. 7 g l^{-1}. The filter was seeded with sewage sludge and the plant was started in August.

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

5601 Radiation Effects

Refer also to citation(s) 28090, 28916, 28988, 29018, 29019, 29045, 29102, 29114

29168 (AD-A–216921/7/XAB) **Index of harm: A measure for comparing occupational risk across industries.** Solomon, K.A.; Alesch, K.A. Rand Corp., Santa Monica, CA (USA). Mar 1988. 43p. (RAND/P–7405). Available from NTIS, PC A03/MF A01.

This paper presents an index of harm methodology that compares occupational risk among workers exposed to radiological and nonradiological harms. It extends the work of the International Commission on Radiological Protection (ICRP) by considering American rather than European and Japanese industry groups, by treating the relative importance of various occupational harms as a parameter rather than an arbitrary constant, and by identifying several ways in which both the methodology and the database could be improved. In the analysis, we examine the risk affects of six occupational harms-three nonradiological (death, accidental injury, and disease or illness) and three radiological (somatic effects, genetic effects, and somatic effects to the fetuses or embryos of pregnant women). We performed our analysis under five different assumptions about the relative importance of averting of the six harms in question. The results of this analysis show that radiological workers exposed to the current industry average of 0.35 rem/yr are among the safest of all industry groupings, and the riskiest industries appear to be mining; agriculture, fishing, and farming; construction; transportation; and manufacturing, roughly in that order.

29169 (AD-A–216984/5/XAB) **Air Transport of Radiation (ATR) code: Development and testing of ATR5. Technical report, 5 April 1985-30 March 1988.** Dolatshahi, F.; Kaul, D.C.; Phillips, J.; Roberts, J.A. Science Applications International Corp., San Diego, CA (USA). 2 Jan 1990. 162p. (SAIC–88/3009). Available from NTIS, PC A08/MF A01.

The Air Transport of Radiation (ATR) code is the standard model for initial radiation dose (kerma free-in-air) from nuclear weapons in uniform air and air-over ground geometries. ATR predicts free field dose from neutron, gamma rays, from a parameterized data base. This report describes modifications made to the code to provide for improved uniform air and air-over-ground dose distributions. Effects of atmospheric moisture are now accounted for. The fission product radiation model has been modified to include contributions from individual fissile isotopes and has been provided with empirical corrections to allow it to better replicate observed dose values. The resulting version of the code is ATR5.

29170 (CONF-900608–4) **Investigation of radiation effects in Hiroshima and Nagasaki using a general Monte Carlo-discrete ordinates coupling scheme.** Cramer, S.N.; Slater, C.O. Nucleo de Estudos e Pesquisas Cientificas do Rio de Janeiro, RJ (Brazil). [1990]. 8p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. From American Nuclear Society annual meeting; Nashville, TN (USA); 10-15 Jun 1990. Order Number DE90005273. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A general adjoint Monte Carlo-forward discrete ordinates radiation transport calculational scheme has been created to study effects of the radiation environment in Hiroshima and Nagasaki due to the bombing of these two cities. Three principal areas of investigation are: (1) to determine by experiment and calculation the neutron and gamma-ray energy and angular spectra and total yield of the two weapons, (2) using these weapon descriptions as source terms, to compute radiation effects at several locations in the two cities for comparison with experimental data collected at various times after the bombings and thus validate the source terms, and (3) to compute radiation fields at the known locations of fatalities and surviving individuals at the time of the bombings and thus establish an absolute cause-and-effect relationship between the radiation received and the resulting injuries to these individuals and any of their descendants as indicated by their medical records. 5 refs., 2 figs.

29171 (CONF-8904186–2) **Recent Increases in Bromus populations on the Nevada Test Site.** Hunter, R. Reynolds Electrical and Engineering Co., Inc., Las Vegas, NV (USA). Environment and Health Div. [1989]. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-89NV10630. From Wildland shrub symposium; Las Vegas, NV (USA); 5 Apr 1989. Order Number DE90009417. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Two introduced grass species, Bromus rubens L. and Bromus tectorum L., have invaded the Mojave and Great Basin Desert vegetation of the Nevada Test Site. One or the other dominates most ephemeral populations. They occur in densities up to thousands per square meter. The ecosystem changes resulting from the grasses include an increased tendency for propagation of fire and a possible decrease in diversity of the native ephemeral flora. 14 refs., 4 tabs.

29172 (DOE/EH–0149T) **A technical review and assessment of the BEIR V [Biological Effects of Ionizing Radiation V] report.** USDOE Assistant Secretary for Environment, Safety and Health, Washington, DC (USA). Mar 1990. 59p. Sponsored by U.S. DOE Environment Health & Safety. Order Number DE90010232. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This report was prepared by the DOE BEIR V Technical Review Committee (TRC) to provide a technical review and assessment of the National Research Council's Bilogical Effects of Ionizing Radiation (BEIR) Committee's Report entitled "Health Effects of Exposure to Low Levels of Ionizing Radiation" (BEIR V). This report contains seven sections. The first section serves as an introduction and reviews the charge to the TRC. The second section is a chapter-by- chapter summary of the BEIR V Report. The third section is a summary of the risk estimates and conclusions of the BEIR V Committee for genetic effects, cancer induction, and in utero effects. The fourth section is a summary and analysis of the new scientific information used by the BEIR V Committee in developing its risk recommendations and conclusions. The fifth section is an assessment of the scientific information and methods used by the BEIR V Committee in developing their risk estimates and conclusions and an analysis of the key assumptions underlying the use of these risk estimates in risk assessment. The sixth section is the TRC'S assessment of the regulatory implications of the BEIR V risk estimates and conclusions for DOE nuclear operations. The seventh and final section is the TRC'S recommended actions for DOE's consideration concerning the BEIR V Report risk estimates and conclusions. 23 refs., 5 tabs.

29173 (DOE/ER–0451P) **A critical review of measurements of the "unattached" fraction of the radon decay products: Radon technical report series.** Hopke, P.K. Clarkson Coll. of Tech., Potsdam, NY (USA). Dept. of Chemistry. Jan 1990. 65p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER60876. Order Number DE90010157. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Exposure to radon and its decay products is known to cause lung cancer. It is the deposition of the decay products within the respiratory tract that delivers the dose leading to adverse health effects. An important concept in understanding the health effects of the radon progeny is the "unattached" fraction. It was suggested that there is a highly diffusive form of the radon and thoron decay products that can be fully deposited in the respiratory system referred to as the "unattached fraction." Initial measurements were made using diffusional deposition in tubes to separate the high diffusivity "unattached" activity from that associated with lower diffusion coefficient particles. Subsequently, wire screens were used to estimate "unattached" Rn daughter fractions in ambient and mine atmospheres. Wire screen penetration theory along with a semi-empirically corrected diffusion coefficient equation can be used to characterize the previously reported "unattached" fraction measurements. Collection efficiency curves have been estimated for previously published wire screen "unattached" fraction measurements and the measurements available in the literature are reviewed and discussed. The purpose for measuring unattached fraction is to estimate the dose to the respiratory tract arising from the deposition of radon decay products to which the individual is exposed. Therefore, if measurements could be made in a manner that better reflected the aerodynamic behavior of the radon progeny in the respiratory tract, then the assessment of exposure could be directly related to dose with far greater accuracy. Respiratory deposition models can serve as basis for such a system and the design concepts of such a measurement system is presented. 104 refs., 34 figs., 7 tabs.

29174 (EGG-BNCT–8777) **Power Burst Facility/Boron Neutron Capture Therapy Program for cancer treatment: Bulletin, Volume 4, No. 1.** Dorn, R.V. III. EG and G Idaho, Inc., Idaho Falls, ID (USA). Jan 1990. 38p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009776. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Highlights of the PBF/BNCT Program during January 1990 include progress within the areas of: gross boron analysis in tissue, blood, and urine; analytical methodologies development for BSH purity determination; noninvasive boron quantitative determination; dosimetry; analytical radiation transport and interaction modeling for BNCT; large animal model studies; neutron source and facility preparation; administration and common support; and PBF operations.

29175 (INIS-SU–164) **1. All-union conference on radiobiology. Vol. 1: Summaries of reports.** AN SSSR, Moscow (USSR). 1989. 253p. (In Russian). (CONF-8908223–: 1. All-Union conference on radiobiology, Moscow (USSR), 21-27 Aug 1989). Order Number DE90706080. Available from NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS.

Individual papers are processed separately for the data base. (DLC)

29176 (KFK–3908) **Calculated distributions of absorbed dose from π^- leaving a magnetic irradiation channel compared to data from experiments.** Hilgendorff, H. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Kernphysik; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Physik. Mar 1985. 53p. (In German). Order Number DE90780366. Available from NTIS (US Sales Only), PC A04/MF A01.

Using the computer program named PIONDOSE transport calculations were carried out for π^--mesons decelerated within a water phantom. The particle beam parameters are those of the biomedical facility of the Swiss Institute for Nuclear Research (SIN) at Villigen/Aargau. The present paper describes the characteristics of a single beam channel and presents the resulting energy distributions in kind of depth dose curves, energy deposition spectra and isodose contours. The calculated dose distributions are faced to measured isodose contours and are found to be in good agreement with each other. Distributions of dose in lineal energy and in contributions from various secondary particles complete the information from experimental dosimetry. (orig.).

29177 (NAC-AR–86-01, pp. 181-187) **The Pretoria cyclotron facility: Radiobiology.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

A technique was developed to decrease significantly the experimental uncertainties related to cell survival data. This technique, single cell mapping, was applied in the low-dose region (1 - 3 Gy) to determine neutron and photon OER values from which the HGF

could be be calculated. Using chromosome aberrations as a biological endpoint, the dicentric frequency was determined as a function of dose in both neutron and photon fields. This study will eventuate in an investigation of synergistic effects in mixed n-γ radiation fields. The mean inactivation dose concept was empirically tested to assess its value in the analysis of survival data and for intercomparison studies. 5 figs., 2 tabs., 5 refs.

29178 (NCRP–106) **Limit for exposure to "hot particles" on the skin.** National Council on Radiation Protection and Measurements, Bethesda, MD (USA). c 31 Dec 1989. 54p. Sponsored by National Council on Radiation Protection and Measurements. Available from National Council on Radiation Protection and Measurements Publications, 7910 Woodmont Avenue, Suite 800, Bethesda, MD 20814.

This report reviews the radiobiological effects of hot particles on the skin and recommends a limit on the product of their beta-particle emission rate and duration of exposure. For the end points addressed by this report, beta particles are the radiation of concern. Relative to the beta particle dose, the gamma radiation associated with a beta-emitting hot particle on the skin does not contribute significantly to the tissue dose in the vicinity of the particle. For the purpose of this report, a hot particle is arbitrarily considered to be a discrete radioactive fragment that is insoluble in water and is no larger than approximately 1 mm in any dimension. In addition, only hot particles directly on the skin are considered in this report. 53 refs., 5 figs., 2 tabs.

29179 (OEFZS–4515) **Cs-137 soil to plant transfer factors derived from pot experiments and field studies.** Horak, O. (Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H. (Austria). Inst. fuer Landwirtschaft); Gerzabek, M.H.; Mueck, K. Oesterreichisches Forschungszentrum Seibersdorf GmbH (Austria). Nov 1989. 13p. (LA–224/89;ST–173/89). Order Number DE90624599. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Soil to plant transfer factors (TF) of ^{137}Cs for different crop plants were determined in pot experiments, in outdoor experiments with plastic containers of 50 l volume, and in field studies. In all cases the soil contamination with ^{137}Cs resulted from fallout after the Chernobyl reactor accident. Mean TF derived for outdoor plants on a fresh weight basis, ranged from 0,0017 (leaf vegetables) to 0,059 (rye straw) and showed characteristic differences depending on plant part and species. Generally, for fruits and potato tubers a lower TF was found than for vegetative plant parts. Moreover, the data were compared with those from former experiments, carried out before the Chernobyl accident. There is a good agreement for cereals (with exception of rye) fruit vegetables and fodder crops, while actual TF are substantially lower for potatoes, leaf and root vegetables, but higher for rye. A significant negative correlation was observed between the TF and the soil activity concentrations for ^{137}Cs. In container experiments the TF were found to be influenced mainly by the clay content of the soil. 11 refs., 2 figs., 2 tabs. (Authors).

29180 (ORNL/FTR–3567) **[Application of dosimetry system DS86 to individual A-bomb survivors]: Foreign trip report, March 7–29, 1990.** Kerr, G. Oak Ridge National Lab., TN (USA). 6 Apr 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009868. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler visited the Radiation Effects Research Foundation (RERF) from March 9 to March 28, 1990. The purpose of this visit was to begin preparation of a report that describes the application of a new dosimetry system (DS86) to individual A-bomb survivors. Such a report is vital to future work of both national and international committees dealing with the health risks of radiation exposure. The traveler, who recently spent a year working at RERF in Hiroshima, will prepare this report in collaboration with the RERF staff. 12 refs.

29181 (ORNL/TM–11424) **A survey of radial growth trends in spruce in the Great Smoky Mountains National Park as influenced by topography, age, and stand development.** Adams, H.S. (Dabney S. Lancaster Community Coll., Clifton Forge, VA (USA)); McLaughlin, S.B.; Blasing, T.J.; Duvick, D.N. Oak Ridge National Lab., TN (USA). Feb 1990. 69p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90007992. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Environmental Sciences Division Publication No. 3427.

A survey of red spruce growth trends at several sites in the Great Smoky Mountains National Park (GSMNP) was undertaken to determine the relationship of the magnitude and timing of changes in annual radial increment to elevation, aspect, tree age, mortality, and competitive status. The growth changes observed suggest responses to changes in climate (principally temperature) or atmospheric pollution acting individually or, more likely, in combination. Major emphasis on these potential causes is warranted in future studies. 56 refs., 8 figs., 11 tabs.

29182 (PNL-SA–17384-HEDR) **Statistical aspects of reconstructing the ^{131}I dose to the thyroid of individuals living near the Hanford Site in the mid-1940s.** Gilbert, R.O.; Napier, B.A.; Liebetrau, A.M.; Haerer, H.A. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 9p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-900438–1: Workshop on statistics of human exposure to ionizing radiation, Oxford (UK), 2-4 Apr 1990). Order Number DE90009449. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In 1988 the Hanford Environmental Dose Reconstruction Project was established to estimate (reconstruct) potential doses that may have been received by individuals from radionuclides emitted with air and water effluents from the Hanford Site in southeastern Washington State, USA, since 1944. This paper discusses some of the statistical methods being developed to assess the uncertainty in reconstructed doses to the thyroid from ^{131}I via the air-pasture-cow-milk-human pathway in the 1944–47 period. Emphasis is placed on assessing dose uncertainties that arise from uncertainties in specification of model parameters. 7 refs.

29183 (SIS–1989:3) **Studies of cellular damage induced by X-rays and visible light: Methods and preliminary studies.** Christensen, T.; Kinn, G.; Reitan, J.B. Statens Inst. for Straalehygiene, Oslo (Norway). 1989. 22p. (In Norwegian). Order Number DE90624533. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

DNA-damage in cells has been studied by use of spectrophotometry and fluorometry. The method is based on the differential fluorescence quantum yield of the fluorochrome Hoechst 33258 when bound to single and double stranded DNA, respectively. DNA-damage by doses of X-rays below 2 Gy was clearly detectable. Blue light from phototherapy lamps induced DNA-damage in human TMG-1 glioblastoma, but no significant effect could be observed after irradiation with green lamps. In the presence of bilirubin the amount of DNA-damage was increased, notably at high bilirubin concentration and by blue light. 9 refs; 12 figs.

29184 Comparison of radium-induced and natural bone sarcomas by histological type, subject age and site of occurrence. Schlenker, R.A. (Argonne National Lab., IL (USA)); Keane, A.T.; Unni, K.K. pp. 188 of Risks from radium and Thorotrast: Proceedings of a workshop held at Bethesda, Maryland, USA from 3 to 5 October 1988 and sponsored by the US National Cancer Institute, the Radiation Protection Programme of The Commission of The European Communities and the US Department of Energy. Taylor, D.M.; Mays, C.W.; Gerber, G.B.; Th. British Institute of Radiology, London (UK) (1989). (CONF-8810248–: ; EUR–12088).

The distributions by histological type, age and anatomical location of 41 bone sarcomas occurring among radium-exposed female dial painters are compared with those for 401 tumours occurring naturally among males and females. No statistically significant differences are found. There is a deficit of bone sarcomas in the axial skeleton compared with the appendicular skeleton and at some sites with large bone surface area, such as the spine, where an abundance of tumours would be expected because of the known positive correlation between tumour frequency and surface area in the major limb bones. The anatomical distribution of radium-induced tumours is not correlated with the distribution of radiation dose nor does it appear to be correlated with the distribution of bone mass or bone surface area throughout the skeleton. (author).

29185 Central nervous system tumours and related intracranial pathologies in radium dial workers. Stebbings, J.H. (Argonne National Lab., IL (USA)); Semkiw, W. pp. 188 of Risks from radium and Thorotrast: Proceedings of a workshop held at Bethesda, Maryland, USA from 3 to 5 October 1988 and sponsored by the US National Cancer Institute, the Radiation Protection Programme of The Commission of The European Communities and the US Department of Energy. Taylor, D.M.; Mays, C.W.; Gerber, G.B.; Th. British Institute of Radiology, London (UK) (1989). (CONF-8810248–: ; EUR–12088).

Among female radiation workers in the radium dial industry there is no overall excess of fatal brain or central nervous system tumours. A significant excess did appear, in one of three major cohorts; the excess was not due to an excess of gliomas and cannot be ascribed with certainty to radium or external radiation. A significant proportional excess of tumours outside of the brain was observed, consistent with irradiation of nervous system tissue from adjacent bone. Excess tumours of the eye, pituitary or pineal did not occur. Early deaths from brain abscess or mastoiditis, coded as diseases of the nervous system and sense organs, were observed. (author).

29186 External radiation doses received by female radium dial painters. Rowland, R.E. (Argonne National Lab., IL (USA)); Lucas, H.F.; Schlenker, R.A. pp. 188 of Risks from radium and Thorotrast: Proceedings of a workshop held at Bethesda, Maryland, USA from 3 to 5 October 1988 and sponsored by the US National Cancer Institute, the Radiation Protection Programme of The Commission of The European Communities and the US Department of Energy. Taylor, D.M.; Mays, C.W.; Gerber, G.B.; Th. British Institute of Radiology, London (UK) (1989). (CONF-8810248–: ; EUR–12088).

It is the purpose of this study to estimate the external dose in the work place, to determine the dose received from these external sources for each female dial painter from the length of time she worked, and to examine the relationship between external dose and the causes of death. (author).

29187 Eye changes induced by radium. Taylor, G.N. (Utah Univ., Salt Lake City, UT (USA). School of Medicine); Lloyd, R.D.; Shabestari, L.; Angus, W.; Mays, C.W.; Muggenburg, B.A. pp. 188 of Risks from radium and Thorotrast: Proceedings of a workshop held at Bethesda, Maryland, USA from 3 to 5 October 1988 and sponsored by the US National Cancer Institute, the Radiation Protection Programme of The Commission of The European Communities and the US Department of Energy. Taylor, D.M.; Mays, C.W.; Gerber, G.B.; Th. British Institute of Radiology, London (UK) (1989). (CONF-8810248–: ; EUR–12088).

Radium-induced intraocular neoplasia has not been reported in people, nor were the intraocular pigmentary changes observed in the beagles described in the dial painters or the radium 226 iatrogenic cases. However, Spiess (1969) has observed a 25% incidence of multiple pigmented naevi in the iris of the radium 224 German cases and Stefani, Spiess and Mays (1986) have noted an abnormal incidence of cataracts in this same group of patients. The reasons for the absence of the much less severe radium-induced eye changes in man as compared to the dog has not been determined. Reference is also made to the authors radium 226 rodent studies with mouse strain onychomys leucogaster. (author).

29188 High linear energy transfer radiation and space missions. Fry, R.J.M. (Oak Ridge National Lab., TN (USA)). pp. 188 of Risks from radium and Thorotrast: Proceedings of a workshop held at Bethesda, Maryland, USA from 3 to 5 October 1988 and sponsored by the US National Cancer Institute, the Radiation Protection Programme of The Commission of The European Communities and the US Department of Energy. Taylor, D.M.; Mays, C.W.; Gerber, G.B.; Th. British Institute of Radiology, London (UK) (1989). (CONF-8810248–: ; EUR–12088).

The radiation environments in space are less benign than on earth. The estimate of radiation hazards and the setting of acceptable exposure limits for missions in low-earth orbits appears to be straightforward. In contrast, the estimation of the radiation risks involved in the exploration of deep space is much more difficult. Not enough is known about biological effects of HZE particles and the prediction of solar particle events and the prediction of solar particle events lacks precision. (author).

29189 The influence of non-uniform α-irradiation of Chinese hamster liver on chromosome damage and the induction of cancer. Guilmette, R.A. (Lovelace Inhalation Toxicology Research Inst., Albuquerque, NM (USA)); Gillett, N.A.; Eidson, A.F.; Griffith, W.C.; Brooks, A.L. pp. 188 of Risks from radium and Thorotrast: Proceedings of a workshop held at Bethesda, Maryland, USA from 3 to 5 October 1988 and sponsored by the US National Cancer Institute, the Radiation Protection Programme of The Commission of The European Communities and the US Department of Energy. Taylor, D.M.; Mays, C.W.; Gerber, G.B.; Th. British Institute of Radiology, London (UK) (1989). (CONF-8810248–: ; EUR–12088).

In this study, Chinese hamsters received intravenous injections of Thorotrast (7.4, 1.5 or 0.30 Bq/g body weight) or monomeric ^{239}Pu citrate (7.4 Bq/g), and were either sacrificed for cytogenetic analysis or held for lifespan dose-response observation. The frequency of chromosome aberrations observed in the Thorotrast-exposed animals was 0.47 aberrations/cell Gy, a frequency similar to that in ^{239}Pu citrate-injected hamsters. Using Cox proportional hazards analysis of the dose-response for several neoplastic and hyperplastic lesions observed in the liver, it was found that the relative risk for each endpoint was increased in a dose-related manner for all three dose levels of Thorotrast, and that risks for the plutonium-injected animals (7.4 Bq/g) were similar to those of the hamsters injected with 1.5 Bq/g Thorotrast. (author).

29190 Multiple components of split-dose repair in plateau-phase mammalian cells: A new challenge for phenomenological modelers. Nelson, J.M. (Pacific Northwest Laboratory, Richland, WA (USA)); Braby, L.A.; Metting, N.F.; Roesch, W.C. *Radiation Research (USA),* 121(2): 154-160 (Feb 1990).

Split-dose experiments using starved plateau-phase Chinese hamster ovary cells have been used to investigate the kinetics of repair, expressed in terms of enhancement of reproductive survival. The results show two distinct components of repair, one having a characteristic time of just over 1 h for the removal of a lesion, the other, about 18 h. The rate at which each component removes damage and the fraction of the total damage that each removes appear to be independent of the initial amount of damage produced, i.e., dose. This lack of dose dependence is not consistent with some simple models of ionizing radiation damage and repair, such as those which assume that saturation of a repair process, depletion of enzyme pools, or the interaction of pairs of sublesions is responsible for the curvature in the dose-response relationship. However, the relationship between the amounts of each type of damage and dose appears to be consistent with models that assume that only a portion of the initial damage is directly accessible to the repair systems or that the initial damage consists of a mixture of potentially lethal and sublethal lesions.

29191 Production of DNA strand breaks by direct effects of heavy charged particles. Holley, W.R. (Lawrence Berkeley Laboratory, Berkeley (USA)); Chatterjee, A.; Magee, J.L. *Radiation Research (USA),* 121(2): 161-168 (Feb 1990).

A theoretical model has been developed to calculate the yields of single- and double-strand breaks in DNA induced by direct effects of ionizing radiation. In this model, which involves no fitted parameters, elements of track structure and stopping power theory are combined with a detailed geometrical description of DNA to calculate the energy deposited by fast charged particles to DNA molecules. The average energy per interaction with a DNA molecule is estimated to be 30 eV from the available data on oscillator strength measurements. These ideas have been incorporated in a Monte Carlo computer program using Poisson statistics to treat the stochastic nature of the energy deposition processes and thereby determine the excitation and ionization states of the molecule. Each ionization reaction on the DNA backbone is assumed to lead to a DNA strand break. In our model double-strand breaks result from nearby independent breaks on opposite strands. Our calculated single- and double-strand break yields compare well with measured cellular data under conditions such that direct effects are thought to dominate strand break production.

29192 Scanning electron microscopy of lung following alpha irradiation. Sanders, C.L. (Pacific Northwest Laboratory, Richland, WA (USA)); Lauhala, K.E.; McDonald, K.E. *Scanning Microscopy (USA)*, 3(3): 907-917; discussion 918 (Sep 1989).

Pulmonary aggregation of inhaled $^{239}PuO_2$ particles leads to a cellular evolution of focal inflammation, fibrosis, epithelial dysplasia and lung tumor formation. Female Wistar rats were exposed to an aerosol of high-fired $^{239}PuO_2$ (initial lung burden, 3.9 kBq) and the lungs examined at intervals from 1 day to 700 days after exposure by light and scanning electron microscopy and autoradiography. Peribronchiolar Pu particle aggregation increased with time, resulting in well-defined focal inflammatory lesions after 120 days and fibrotic lesions after 180 days. A generalized hypertrophy and hyperplasia of nonciliated bronchiolar cells was seen at 15 days and type II cell hyperplasia by 30 days after exposure. Focal dysplastic changes in type II alveolar epithelium and terminal nonciliated bronchiolar epithelium preceded carcinoma formation. Alveolar bronchiolarization was first noted at 120 days, squamous metaplasia at 210 days, squamous carcinoma at 270 days and adenocarcinoma at 600 days after exposure.

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Refer also to citation(s) 27515, 27520, 27521, 27523, 27566, 27948, 28311, 28570, 28966, 28992, 28993, 29001, 29006, 29007, 29008, 29011, 29014, 29102, 29125

29193 (AD-A-216819/3/XAB) **Mechanisms of cellular membrane effects of TCDD, selected perfluorinated acids, and polyhalogenated aromatic hydrocarbons. Forecast report.** Rogers-Back, A. Microbiological Associates, Bethesda, MD (USA). 1 Feb 1985. 8p. Available from NTIS, PC A02/MF A01.

The first six months of the contract have been devoted to examining the effects of perfluorinated acids and polyhalogenated aromatic hydrocarbons on the colony-forming ability of L5178Y cells. Two subclones of this cell line have been utilized. One subclone is designated L5178Y TK+/. The two cell lines differ markedly in their growth characteristics. L5178Y TK+/- cells tend to associate in clumps of cells and are grown in a shaker incubator to produce better cell suspensions. L5178Y TK+/+ cells grow as a single cell suspension without agitation. The toxic response of both cell lines after treatment with the perfluorinated acids (perfluoro-n-decanoic acid) was measured. In summary, the results for the perfluorinated acids with chain length of 9 or 10 indicate that there is some dissociation of colony growth from suspension growth. Medium type does not affect the toxicity. This would imply that these perfluorinated acids are producing toxicity through a membrane interaction. The dissociation appears to occur in the TK+/+ cells at concentrations approximately 20 higher than those previously reported.

29194 (DFVLR-FB-89-07) **Signature analysis and classification results of pine of different vitality classes using airborne thematic mapper data.** Herrmann, K. (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Wessling (Germany, F.R.). Inst. fuer Optoelektronik). Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Koeln (Germany, F.R.); Muenchen Univ. (Germany, F.R.). Forstwissenschaftliche Fakultaet. 1989. 189p. (In German). Order Number DE90773660. Available from NTIS (US Sales Only), PC A09/MF A01.

Aim of the investigations was to gain more informations about reflection properties of pines (Pinus sylvestris) with special regard to damage symptoms. Remote sensing was carried through by aerial monitoring with multispectral scanners. The results are discussed and are well corresponding with the results of terrestrial investigations. (KG) With 98 figs., 38 tabs., 136 refs.

29195 (DGMK-400-6) **Guidelines for safe handling of marine fuels.** Jungen, H. Deutsche Wissenschaftliche Gesellschaft fuer Erdoel, Erdgas und Kohle e.V., Hamburg (Germany, F.R.). Jul 1988. 28p. (In German). Available from Deutsche Wissenschaftliche Gesellschaft fuer Erdoel, Erdgas und Kohle e.V., Hamburg (Germany, F.R.).

When properly used for their intended purpose and with good standards of personal and occupational hygiene, marine fuels are unlikely to present a short or long term health risk, given the closed systems under which they are normally stored, handled and consumed. However, where good standards are not maintained, health hazards can arise. This report advises end users of marine fuels of the potential hazards, the recommended precautions for safe handling and use, and on first aid treatment for accidental exposure. (orig.).

29196 (DOE/ER-0450T) **Effects of air temperature on atmospheric CO_2-plant growth relationships.** Allen, S.G. (Agricultural Research Service, Phoenix, AZ (USA). Water Conservation Lab.); Idson, S.B.; Kimball, B.A.; Baker, J.T.; Allen, L.H. Jr.; Mauney, J.R.; Radin, J.W.; Anderson, M.G. Agricultural Research Service, Phoenix, AZ (USA). Water Conservation Lab.; Agricultural Research Service, Gainesville, FL (USA); Western Cotton Research Lab., Phoenix, AZ (USA); Florida Univ., Gainesville, FL (USA); Arizona State Univ., Tempe, AZ (USA). Apr 1990. 61p. Sponsored by U.S. DOE Energy Research. DOE Contract AI01-81ER60001. Order Number DE90010159. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The carbon dioxide concentration of the earth's atmosphere is increasing and expected to double some time during the middle of the next century. In addition, climate models predict that due to the "greenhouse effect", increased atmospheric CO_2 may cause a warming of the earth's surface of 1.5 to 4.5°C. The separate effects of atmospheric CO_2 concentration and temperature on plant processes has been studied extensively. In general, a doubling of CO_2 results in about a one-third increase in productivity of C_3 plants, although a wide range of responses have been reported. This report reviews research concerned with the CO_2 by temperature interaction effects on plants, with an emphasis on experiments conducted in outdoor, CO_2-enriched environments. 102 refs., 28 figs., 4 tabs.

29197 (EPRI-EN-6785) **Sulfur dioxide and ozone effects on crops: Final report.** Amundson, R.G. (Cornell Univ., Ithaca, NY (USA)); Kress, L. Electric Power Research Inst., Palo Alto, CA (USA); Boyce Thompson Inst. for Plant Research, Ithaca, NY (USA); Forest Service, Research Triangle Park, NC (USA). c Apr 1990. 164p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

In order to determine if exposure to O_3 and SO_2 in combination produce greater-than-additive effects on yields of economically important crops, corn, wheat, soybean, alfalfa, and a mixed forage crop of timothy and red clover were exposed to SO_2 and O_3 using open-top chambers in six separate experiments during three field seasons. In five of the six studies changes in physiology and/or growth were also assessed to help determine short-term responses of the plants to the exposures. Monitoring of several physiological responses of the crops provided a means of assessing short term effects of the SO_2 exposures on the crops and helped in interpretation of the effects on yields. 4 refs., 46 figs., 49 tabs.

29198 (GSF-6/89) **1st PBWU status seminar on forest decline. Proceedings.** Reuther, M.; Kirchner, M. (eds.). Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. 517p. (In German). (CONF-8902175--: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). Order Number DE90773485. Available from NTIS (US Sales Only), PC A22/MF A01.

The conference was to provide a status report on forest decline research carried out by the PBWU on behalf of the Bavarian State Minister for Regional Development and Environmental Affairs. Forest decline research in Bavaria focuses on certain aspects of the problem and on certain regions. Regional sites of interdisciplinary research are located in the Fichtelgebirge mountains, Bayerischer Wald mountains, the 'Hoeglwald' forest between Munich and Augsburg, and the 'Wank' forest near Garmisch-Partenkirchen. After some general lectures, these sites were discussed one by one at the meeting and are discussed here in the same order. As the PBWU are only part of the total activities in each field, each section of this volume starts with a survey paper and papers refering to non-PBWU activities have been included in order to obtain a

comprehensive picture. Separate records are available in this database for 36 papers of this seminar. (orig./MG).

29199 (GSF–6/89, pp. 5-19) **Forest decline research at the Bavarian Forest National Park.** Knorr, A. (Bayerische Forstliche Versuchs- und Forschungsanstalt, Muenchen (Germany, F.R.)). Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

The foundation of the National Park trigged a wide array of hydrological, climatical, floristical and hydrogeological field studies. The sampled data proved to be an important basis for the forest decline research in providing excellent information for properly selecting and equipping of experimental sites to be installed in other areas on one hand and for appropriate interpretation of obtained results on the other. Numerous interdisciplinary research projects are installed at the same experimental site, thus allowing interpretation from various fields of work. The following paragraph lists focal points of research work: Survey and documentation of forest decline by ground based and aerial determination as well as through bioindicators, soil tests in forest stands with various damage stages, studies of increment, annual ring- and crownstructure in forest stands with various damage stages, inquiries about dry and wet inputs, internal nutrient cycle and outputs by runoff and percolating water of forest stands, measurements on concentration and shifts of air pollutants within the canopy, studies of plant physiology. (orig.).

29200 (GSF–6/89, pp. 51-60) **Metabolic studies in a Norway spruce stand (Picea abies Karst.) in the high mountain region of Eastern Bavaria.** Kreutzer, K. (Muenchen Univ. (Germany, F.R.). Lehrstuhl fuer Bodenkunde); Heil, K. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Water and matter fluxes in a Norway spruce stand on podsol at high elevation (1203 m) in East Bavaria were investigated in 1987 and 1988. Water turnover is characterized by annual precipitations of 1700 to 1900 mm, causing seepage of around 1300 to 1600 mm. Total concentration of ions in seepage water at 60 cm depth is 400 to 500 μmol IE L^{-1} with Al^{3+} as dominating cation (300 to 350 μmol IE L^{-1}) and SO_4^{2-} ($\simeq$ 200 μmol IE L^{-1}) and NO_3^- (130 to 270 μmol IE L^{-1}) as dominating anions. In the soil solution the mean molar ratios of Ca/Al resp. Mg/Al are 0.19 resp. 0.10. The strong aluminium mobilization seems to be related to acidic deposition from the atmosphere (2.2 to 2.6 kmol proton input ha^{-1} a^{-1}) and to soil internal proton production by surplus nitrification (1 to 3 kmol ha^{-1} a^{-1}). The intensity of the latter process is varying from year to year due to outstanding warm and dry weather periods. Aluminium pushes caused by that may be responsible to some extent for the appearance and intensity of the magnesium deficiency symptoms on the spruces appearing since eight years but significantly varying in its intensity with time. Also nitrate leaching from the soil is influenced. An efflux of around 58 kg N ha^{-1} a^{-1} were found in 1988 and around 25 kg in 1987. Throughfall input amounts to around 20 to 25 kg N ha^{-1} a^{-1}. But total input may be higher due to N assimilation in the tree crowns which could not be realized completely. (orig.).

29201 (GSF–6/89, pp. 61-73) **Induction and healing of acute yellowing in spruce trees as a function of nutrient supply.** Senser, M. (Muenchen Univ. (Germany, F.R.). Botanisches Inst.); Hoepker, K.A. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

The symptoms of the spruce disease 'acute yellowing' are experimentally inducible and reversible. This was demonstrated by a container experiment with 3 years old spruce trees of different provenances using a forest soil. During the second year of the experiment the initially healthy trees developed symptoms of 'acute yellowing' on the forest soil. To date (after 4 years), however, no symptoms of yellowing have become apparent on the forest soil having been mixed with gardening mould (1:1) or fertilized with NPK(MG). 'Acute yellowing' could also be prevented by fertilization of the forest soil with only K or K in combination with other nutrients. In the case of already 'acute yellowed' young trees the combination forest soil + gardening mould resulted in a regreening of the twigs, whereas the symptoms of the disease persisted in the unfertilized forest soil. The supply of K to the needles was improved when the nitrogen-poor forest soil was fertilized with N (NO_3-N, NH_4-N) in addition to K. However fertilization with N but not K intensified the symptoms of 'acute yellowing'. The correlation between the occurrence and reversal of the 'acute yellowing' and the mineral supply of the needles was revealed by continuous estimations of the contents of the pigments and nutrient elements. (orig./MG).

29202 (GSF–6/89, pp. 75-87) **Development of acute yellowing in spruce trees.** Kandler, O. (Muenchen Univ. (Germany, F.R.). Botanisches Inst.); Miller, W. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

The development of 'acute yellowing' and regreening in spruce was followed by visual observations and by pigment, mineral and soil analyses. Studies of the population dynamics in stands revealed a small-scale spatial and temporal mosaic of yellowing and regreening trees, which was reflected by the Mg content of the needles, but not by changes in pH and in the amount of ammonia-exchangeable Mg in soil samples taken from the rooting areas of diseased and of healthy trees. These findings are not compatible with the assumption of an ecosystemic cumulative damage by air pollutants and their depositions, which should lead to an irreversible and much more uniform decline within the stands. The findings rather suggest an overlapping of a latent Mg deficiency with reversible damages (diseases) of the mycorrhizae, roots or vascular bundles of individual trees, which lead to an inhibition of the uptake or translocation of Mg resulting in acute Mg deficiency symptoms on soils poor in available Mg. (orig.).

29203 (GSF–6/89, pp. 89-94) **Gas exchange experiments on spruce trees in pure and ambient air in order to determine the air pollutant stress of the stand.** Koch, W. (Muenchen Univ. (Germany, F.R.). Lehrstuhl fuer Forstbotanik). Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

A fumigation experiment with spruce in pure and ambient air has been running in the forest district Thiergarten, Bavarian Forests, since 1985. Apart from total gas exchange, the air pollutant stress of the stand is continually monitored. Since mid 1988 ozone and SO2 are added to the system at ambient levels and the twig in the chambers are simultaneously sprinkled with pure and acid rain resp. To date there are no differences in the daily courses or the balance. Forest growth data show clear signs of recovery during the last five years. (orig.).

29204 (GSF–6/89, pp. 95-106) **Effects of immissions on spruce stand ecosystems - results of forest damage research in the Fichtelgebirge mountains.** Schulze, E.D. (Bayreuth Univ. (Germany, F.R.). Lehrstuhl Pflanzenoekologie). Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

In the study area of the Fichtelgebirge, the existing exposure to high concentrations of gaseous pollutants has had no long-lasting effect on needles of spruce; pathogens have only been secondary agents of the observed forest decline symptoms. Deposition of sulfur, nitrate, and ammonium, however, have significantly modified soil chemistry and plant nutrition. Spruce roots take up ammonium rather than nitrate with a negative antagonistic effect on Mg. Nitrate, left in the soil solution, is leached to groundwater together with sulfate, accelerating soil acidification and decreasing the Ca/Al and Mg/Al ratios in the soil solution. Soil solution chemistry affects root development and water and nutrient uptake by trees. Had all nutrients become equally deficient, spruce trees probably could have adjusted by retarding their growth, however, canopy uptake of atmospheric nitrogen in addition to root uptake stimulated growth, and caused a nitrogen to cation imbalance resulting in forest decline symptoms (Schulze, 1989). (orig.).

29205 (GSF–6/89, pp. 107-118) **Annual curves of changes in chloroplast pigments in a polluted spruce stand in the Fichtelgebirge mountains as a function of age and mineral nutrition of the needles.** Koestner, B. (Wuerzburg Univ. (Germany, F.R.). Inst. fuer Botanik und Pharmazeutische Biologie); Lange, O.L.; Czygan, F.C. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Annual time courses of changes in chloroplast pigments in both chlorotic and healthy spruce at the Oberwarmensteinach (Fichtelgebirge) study site indicate that pigment bleaching in damaged trees results from less accumulation of pigments in young needles during spring/summer and an additional decrease of pigments in older needles during late summer/fall. Correlations of pigment characteristics with mineral nutrition and photosynthetic capacity indicate that pigment reduction is physiologically regulated and results from magnesium deficiency in the needles rather than directly through damage by atmospheric pollutants. (orig.).

29206 (GSF–6/89, pp. 119-133) **Uptake, discharge and metabolism of NO_x, NH_4^+ and nitrate in forest trees, especially spruce trees.** Schulze, E.D. (Bayreuth Univ. (Germany, F.R.). Lehrstuhl Pflanzenoekologie); Gebauer, G. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Different nitrogen isotope ratios were found by mass spectrometry for different compartments of Norway spruce plants and for plants from declining and healthy sites of the Fichtelgebirge which reflect important differences during metabolism and transport of N containing substances within the trees. Laboratory irrigation and fumigation experiments showed that the N uptake via needles and bark can become a considerable amount for the total N nutrition of spruce. The uptake of gaseous NO_x via the needle surface is more important than the uptake of ammonium from wet depositions. Only small amounts of nitrate are taken up by the needle surface. N uptake rates are different for spruce trees which are in a different nutritional status. (orig.).

29207 (GSF–6/89, pp. 145-154) **Effects of acid rain and liming on a spruce site (Hoegiwald project).** Kreutzer, K. (Muenchen Univ. (Germany, F.R.). Lehrstuhl fuer Bodenkunde); Schierl, R.; Goettlein, A. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

An acid irrigation and liming experiment in an around 80 years old Norway spruce stand (Picea abies L. Karst.) on acid hapludult (pH (H_2O) 4.2, Ca/Al 0.3 at 20 cm depth) in Southern Bavaria was started in 1982. Up to now acid irrigation with 2.7 to 2.8 (mean annual input around 4 kmol H^+ ha^{-1}) caused only a pH decrease of 0.3 to 0.5 pH units, confined to the upper part of the organic surface layer. Almost the entire H^+ addition was buffered. The main buffering reactions were cation exchange in the upper part of the mineral soil, which were contributing to the buffering to around 15 resp. 80% of the H^+ addition. The cation exchange was connected with a strong reduction of the cation exchange capacity due to protonation of organic functional groups. Also leaching of the released cations Ca, Mg, Mn, K occurred. In the mineral soil the Al concentration increased but no change in Ca/Al and Mg/Al ratios because of leaching input from the organic layer above. Up to now the stand shows no severe damage symptoms in contrast to the ground flora and microorganisms. The absence of tree damages may be due to the fact, that the trees have access to horizons with better nutrient supply. That enables them to develop defensive mechanisms in the 'Al stress' horizons as pH increase on the rhizoplan and Al complexation in the mucilage. Mobilization of heavy metals, due to acidic treatment, was observed. Only Mn effect on Oxalis is suggested. Liming caused strong increase of nitrification and nitrate leaching before the background of an excess N supply mainly due atmospheric N input. Al, Pb and Cu were also mobilized by liming due to a hydrolysis-induced increase of soluble organic C, forming complexes with these metals. (orig.).

29208 (GSF–6/89, pp. 155-164) **What is a plant-damaging substance?** Ziegler, H. (Technische Univ. Muenchen (Germany, F.R.). Inst. fuer Botanik und Mikrobiologie). Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

A review is given about the different types of anthropogenic plant damaging substances (APDS). We should distinguish between such compounds which are useful for the plant in low and toxic and higher concentrations, and others which are obstructive in any effective concentration. It is emphasized that there is a decisive difference between the toxicity of a compound for a single, isolated

plant and its effect on a plant in its natural environment. Definitions are given for APDS for single non-crop plants, for APDS for crop plants and for APDS for natural vegetation. (orig.).

29209 (GSF–6/89, pp. 165-184) **Effects of SO_2 on chloroplasts and leaves.** Dittrich, A. (Wuerzburg Univ. (Germany, F.R.). Inst. fuer Botanik und Pharmazeutische Biologie); Yin, Z.; Wagner, U.; Kolbowski, J.; Heber, U. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Uptake of SO_2 into leaves takes place almost exclusively through opened stomata. It can be calculated quantitatively after stomatal and boundary layer resistances have been determined. Inside the leaves, SO_2 diffuses across the plasmalemma of mesophyll cells. In the cytosol, it reacts with water to form H^+, HSO_2^- and SO_2^{2-}. Rates of the light-dependent reduction and oxidation of the anionic species and formation of adducts have been measured in chloroplasts as a function of concentration. Oxidation which involves radical reactions can be effectively suppressed by radical scavengers. Light-dependent cysteine-synthesis competes with oxidation and adduct formation. It is increased in the presence of O-acetylserine. Cytoplasmic acidification by H^+ can be compensated metabolically. Mineral deficiency and low temperatures decrease the ability of leaves to maintain cytoplasmic pH-stability. Results are discussed in relation to the contribution of SO_2 to forest decline in areas known to be exposed to atmospheric pollutants. (orig.).

29210 (GSF–6/89, pp. 185-194) **Sulfate and nitrate concentrations in needles and leaves as indicators of SO_2 or NO_2 pollution.** Lanzl, A. (Wuerzburg Univ. (Germany, F.R.). Lehrstuhl fuer Botanik 1); Kaiser, W.M.; Fuehrer, G.; Lippert, M. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Older needles of spruce trees from the Fichtelgebirge mountains contain sulfate and total sulphur concentrations in the some order of magnitude as found in spruce exposed to 1000 ppb SO_2 for 23 days (7 h per day). In gassing experiments on spruce and barley, the sulfate accumulation was used as an indicator of the minimum uptake of SO_2. The resulting H^+ exposure from H^+ released in needles and leaves ought to induce toxic pH changes in plant cells, but no significant pH changes were found in homogenized samples of leaves and needles. Further, there was no indication of proton discharge via the plant roots. The authors therefore concluded that the acid uptake is compensated for by basification or by acid decomposition, resulting in an unexpectedly high SO_2 tolerance of the plants. Exposure of spruce to 1000 ppb NO_2 (23 days) induced no measurable changes in the nitrate concentration. There appeared to be a quantitative reduction of the accumulated NO_2. No damage was observed. (orig.).

29211 (GSF–6/89, pp. 195-206) **Effects of environmental pollutants on photosynthesis and cell membranes of plants.** Urbach, W. (Wuerzburg Univ. (Germany, F.R.). Lehrstuhl fuer Botanik 1); Schmidt, W.; Kolbowski, J.; Ruemmele, S.; Reisberg, E.; Steigner, W.; Schreiber, U. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Effects of SO_2 and O_3 on photosynthetic processes of intact leaves and needles were investigated by means of fluorescence measurements. Changes of plant membrane properties by these air pollutants were analyzed by electrophysiological investigations with the unicellular green alga Eremosphaera viridis: SO_2 mainly effects the enzymatic processes of CO_2-fixation by acidification of the cell compartments. Exposures to O_3, however, primarily increase membrane permeability before photosynthesis is distinctly damaged. On the basis of reaction rates of O_3, calculations of O_3 uptake and distribution in different compartments of mesophyll cells have been carried out. (orig.).

29212 (GSF–6/89, pp. 207-214) **The contribution of photoinhibition to the effects of airborne pollutants on the photosynthesis apparatus.** Winter, K. (Wuerzburg Univ. (Germany, F.R.). Lehrstuhl fuer Botanik 2); Winkelmann, E.; Koeniger, M. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

The research project was to find out in howfar the negative effects of air-borne pollutants (e.g. SO_2) on photosynthesis, metabolic production and survival rates of deciduous and coniferous trees are enhanced, or even triggered, by high light intensities. In the course of a preliminary experiment without exposure to various gases, Nordmann's silver fir trees aged four to five years were cultivated in unshaded and shaded sites (70% reduction of the natural quantum flux). Yearly measurements of photosynthetic O_2 evolution in conditions of limited and saturated light as well as chlorophyll fluorescence measurements showed a marked inactivation of the photosyntheses apparatus in the cold season for the unshaded trees. This effect was less noticeable or non-existed in shaded trees. In order to determine the influence of high quantum flux in case of SO_2 exposure, sun leaves of Populus balsamifera L. were exposed for 8 hours to an extremely high atmospheric SO_2 concentration, both in darkness and in strong light. Unexpectedly, SO_2 exposure in darkness caused a much stronger decrease in the quantum yield and capacity of photosynthetic O_2 evolution than SO_2 exposure at 1550 μmol photons m^{-2} s^{-1}. It seems that light favours repair and detoxification processes which counteract the toxid effects of SO_2. Photoinhibition in the narrower sense was observed, however, when leaves pretreated for 8 hours in darkness with 2 ppm SO_2 were exposed the next day to a combination of strong light (1550 μmol photons m^{-1} s^{-1}) and unpolluted air. (orig./MG).

29213 (GSF–6/89, pp. 215-225) **Intracellular compartimentation of abscisic acid (ABA) in guard cells and mesophyll cells under exposure to SO_2.** Baier, M. (Wuerzburg Univ. (Germany, F.R.). Lehrstuhl fuer Botanik 1); Daeter, W.; Hartung, W. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

The effect of SO_2 on the intracellular compartimentation of ABA in guard cells and mesophyll cells of Valerianella locusta was investigated, using the efflux compartmental analysis, as described by Behl and Hartung (1986). The cytoplasmic ABA content of the guard cells was reduced drastically by 6 μmolxm^{-3} SO_2 (20% of

the controls). The vacuolar content was decreased less dramatically (70% of the controls). The ABA distribution of mesophyll cells remained uneffected by 6 μmolxm^{-3} SO_2. The SO_2 effects are explained by an acidification of the compartments. (orig.).

29214 (GSF–6/89, pp. 227-235) **The influence of peroxides on photosynthesis in spruce (Picea abies).** Maguhn, J. (Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Oekologische Chemie); Gaeb, S.; Knoppik, D.; Selinger, H.; Drenkard, S. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

To determine the adverse effects of peroxidic air pollutants that are built up in the lower troposphere by photochemical reactions, their influence on photosynthesis in spruce has been investigated. By means of a gas-exchange-measurement system the net assimilation rate A and the stomatal conductance g^{ca} of a spruce twig have been observed during fumigation with ozone, hydrogen peroxide, methyl hydroperoxide, PAN, PPN, or PBzN. In addition, CO_2-response curves of A have been made in order to determine several important physiological parameters. Changes in these parameters caused by the peroxides allow the site and extent of an injury to be estimated. (orig.).

29215 (GSF–6/89, pp. 237-242) **Biochemical changes in the metabolism of affected beech trees (Fagus sylvatica L.) - secondary plant metabolites (phytoalexins) related to the pathogenic situation.** Sonnenbichler, J. (Max-Planck-Institut fuer Biochemie, Martinsried (Germany, F.R.)); Zielke, H. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

By quantitative analyses of low molecular weight compounds (m.w. < 1000) in beech leaves of trees under normal growth conditions and of trees affected by forest decline and exposed to ozone and pathogens, the relation between the synthesis of secondary plant metabolites (phytoalexins) and the pathogenic situation is investigated. (orig.).

29216 (GSF–6/89, pp. 243-251) **Sorption and permeation characteristics of cuticles for monoterpenes, with particular regard to the effects of gaseous pollutants on spruce trees.** Schoenwitz, R. (Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl fuer Botanik); Schmid, C. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Partition coefficients of ^{14}C-limonene were determined for the system 'isolated cuticle /water'. For this reason sorption experiments were run using astomatous cuticles of Citrus, Ficus and Abies and stomatous cuticles of Picea. For all sorts of cuticles tested, the partition coefficients are about 10^5. This value validates a high accumulation of terpenes within the cuticle - an interesting aspect viewed from the standpoint of the repelling of pathogens by toxic terpenes. (orig.).

29217 (GSF–6/89, pp. 253-260) **Sorption and permeation properties of plant cuticles for gaseous pollutants and water after exposure to gaseous pollutants.** Lendzian, K.J. (Technische Univ. Muenchen (Germany, F.R.). Inst. fuer Botanik und Mikrobiologie). Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Plant cuticles are permeable to SO_2 and NO_2 but not to O_3. The permeation is determined by three processes, i.g. sorption, diffusion and desorption. The overall process has been characterized by the permeance. The aim is to differ between the three transport parameters. Examples for experimental solutions are given. The ecological significance of binding of NO_2 to cuticular structures is discussed. (orig.).

29218 (GSF–6/89, pp. 261-270) **Simulation and analysis of the loss of inorganic ions from leaves under exposure to acid rain and airborne pollutants.** Riederer, M. (Technische Univ. Muenchen (Germany, F.R.). Inst. fuer Botanik und Mikrobiologie). Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

The leaching of K^+, Cs^+, Mg^{2+} and Ca^{2+} has been studied under controlled conditions using isolated cuticular membranes from Citrus aurantium and leaf disks from Quercus robur, Fagus sylvatica and Robinia pseudoacacia. The steady state flow rate of cations across the cuticle depended on the H^+ concentration of the washing solution. This can be explained by an exchange process involving the counterions. Another component of leaching was the dissolution of ions from the leaf surface transported there across the cuticle during periods of time free of precipitation. High doses of ozone resulted in a significant increase of cation flow rates. (orig.).

29219 (GSF–6/89, pp. 271-280) **Quantitative studies on pollutant uptake by leaves: Cuticular permeability with particular regard to lateral heterogeneity of leaf surfaces.** Schoenherr, J. (Technische Univ. Muenchen (Germany, F.R.). Inst. fuer Botanik und Mikrobiologie); Schreiber, L.; Svenningson, M. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Methods suitable for determining uptake of solutes into leaves and needles are presented and discussed. Permeances (P) of cuticles of all leaves tested increased with decreasing polarity of test compounds (urea, 2,4-D, pentachlorophenol). Most uptake kinetics are biphasic, indicating that uptake proceeds into two compartments differing in permeability and capacity. Differences in P between compounds and species are difficult to interpret, since wettability of leaves is not the same for all leaves and the exact contact area between cuticle and solution is not known. (orig.).

29220 (GSF–6/89, pp. 281-292) **Microscopic structure and dynamics of plant cuticles and their modification during exposure to pollutants.** Sackmann, E. (Technische Univ. Muenchen, Garching (Germany, F.R.). Inst. fuer Biophysik); Wunderlich, A.P. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen,

Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175--: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

The temperature dependence of the local diffusion of fluorescent molecular probes of various polarity (alcanes, long chain fatty acid, short chain alcohol and fatty acid), all labeled with 7-nitrobenz-2-oxa-1,3-diazol-4-yl (NBD) in the cuticle of Clivia Miniata is studied by the photobleaching (FRAP) technique. The technique yields the coefficient of diffusion, D, in the plane of the cuticle over distances of some 30 μm and the fraction, R, of mobile reporter molecules. The inner (more hydrophilic) and the outer (more hydrophobic) face of the cuticle is studied separately by appropriate incubation. This yields different values of D. Ozone exerted during the growth of the plant causes an increase of the diffusion coefficient, both in the outer and the inner layer of the cuticle, e.g. by a factor of 2 for the alcane diffusion in the hydrophobic outer face. This points to defects in the polymerized matrix. (orig.).

29221 (GSF–6/89, pp. 293-298) **Investigations of the mycorrhiza reactions to ozone and acid mist.** Weiss, M. (Muenchen Univ. (Germany, F.R.). Inst. fuer Systematische Botanik). Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175--: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

In several experiments the root system and the mycorrhizae of Picea abies were studied in their reaction to different soils and to application of ozon and acid mist. While significant responses to substrat could be found, the tested parameters in most cases did not show significant reactions to the applicated ozon and acid mist. (orig.).

29222 (GSF–6/89, pp. 299-313) **Experience and findings of experiments in the GSF exposure chambers.** Payer, H.D. (Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Biochemische Pflanzenpathologie). Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175--: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Four walk-in environmental chambers were installed in the GSF in 1984/85, in which the effects of air pollutants and climate on plants can be investigated. They were particularly intended to promote the causal analysis of forest damage. The following factors were studied: O_3, SO_2, NO_2, acid mist, PAN, mineral supply, frost effects, biological factors such as parasites, genetic and developmental constitution. Approx. 80% of the studies focussed on the effect of O_3 on plants. With regard to the significance of the investigated factors for forest damage it is concluded, that most of the factors can lead to effects which may contribute to the development of tree damage. The complexity of the subject, however, impedes definite conclusions e.g. concerning threshold values which are the basis for immission limits. (orig./MG).

29223 (GSF–6/89, pp. 315-325) **Element concentrations in rings of injured trees.** Elling, W. (Fachhochschule Weihenstephan, Freising (Germany, F.R.). Fachbereich Forstwirtschaft); Fiedler, C.; Schramel, P. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175--: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Spruce trees from 4 different sites in Bavaria were investigated by dendrochronological and chemical methods. Time course and extent of injury are established by dendrochronological procedures. Annual increment layers of the wood were separated by tools made of silicon nitride, to avoid contamination of samples. Using different techniques of chemical analysis, concentrations of 20 elements were determined. The suitability of these elements for monitoring changes in environmental conditions is discussed; special attention is directed to the possibility of radial transport in the bole of trees. The most promising elements are Fe, Al, Ti, Cr and Ni. (orig.).

29224 (GSF–6/89, pp. 417-432) **Gas exchange measurements as a method for early detection of tree damage in mountain forest sites.** Knoppik, D. (Technische Univ. Muenchen, Freising (Germany, F.R.). Lehrstuhl fuer Physik); Selinger, H.; Dunkl, M. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175--: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Gas exchange measurements are analysed on the basis of a photosynthesis model. This yields a lot of characteristic parameters which can be changed due to pollutants. An improved method of analysing measurements of chlorophyll fluorescence gives additional information about injuries of the photosynthetic apparatus. These methods were applied in indoor and outdoor experiments for investigation of a possible influence especially of photooxidants on photosynthesis. (orig.).

29225 (GSF–6/89, pp. 433-442) **Laboratory comparison of the stomatal opening behaviour of alpine fir trees and ozone-burdened trees.** Maier-Maercker, U. (Muenchen Univ. (Germany, F.R.). Lehrstuhl fuer Forstbotanik). Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175--: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Specially designed experiments confirm the hypothesis that O_3 specifically disturbs water balance. A poor water balance caused by irregular stomatal behaviour appears in twig material treated with O_3 and also in damaged material from Wank. The resulting reduction in osmotic potential of damaged needles is examplarily shown in cuvette experiments and in the stand in Wank. The effect of the emissions is interpreted as a shift of the set point of the sensor in the stomatal control loop. (orig.).

29226 (GSF–6/89, pp. 443-455) **Peroxide detoxification of spruce needles in forest sites of the Northern Alps (Wank).** Polle, A. (Fraunhofer-Institut fuer Atmosphaerische Umweltforschung (IFU), Garmisch-Partenkirchen (Germany, F.R.)); Rennenberg, H. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175--: 1. PBWU status seminar on forest decline,.

Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

Photooxidants have been assumed to play a major role in the new-type forest decline observed in the Northern Alps. This group of air pollutants may raise the cellular content of toxic oxygen species and can affect the detoxification metabolism for these harmful compounds. Therefore, in the current project we investigate the content of peroxides, the content of antioxidants, as well as the activity of enzymes related to the metabolism of toxic oxygen species in needles of damaged and healthy spruce trees. As an example, we report on seasonal changes of the activity of superoxide dismutase, its dependency on the degree of injury of the trees, and its relation to the elevation of the forest. (orig.).

29227 (GSF–6/89, pp. 477-486) **Effects of air pollutants and other stress factors on phytohormone concentrations in trees.** Schneider, P. (Technische Univ. Muenchen, Freising (Germany, F.R.). Fakultaet fuer Landwirtschaft und Gartenbau); Horn, K.; Hock, B. Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

It was investigated whether air pollutants and other stress factors caused concentration changes of the gibberellin GA_3 in needles of Norway spruce. For this purpose, clonal material was assayed, which had been treated with ozone and acid mist over 14 months under controlled conditions in the exposition chambers of the GSF. In addition, trees of the habitat 'Wank' were analyzed. GA_3 was extracted and purified by 4 clean-up steps including HPLC. An enzyme immunoassay was used for the quantitative determination. No significant differences could be detected between the samples, treated with ozone plus acid mist, and the controls. Furthermore, no correlation could be found, so far, between the degree of damage of the trees at the habitat 'Wank' and the GA_3 concentrations in needles. (orig.).

29228 (GSF–6/89, pp. 487-496) **Analysis of phytohormones and secondary plant products (main flavonoids and terpenes) in healthy and damaged needles from the natural location.** Kraus, M. (Technische Univ. Muenchen (Germany, F.R.). Inst. fuer Botanik und Mikrobiologie). Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen, Neuherberg (Germany, F.R.). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU); Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany, F.R.). Jul 1989. (In German). (CONF-8902175–: 1. PBWU status seminar on forest decline, Neuherberg (Germany, F.R.), 27 Feb - 1 mar 1989). In *1st PBWU status seminar on forest decline. Proceedings.* Order Number DE90773485. Available from NTIS (US Sales Only), PC A23/MF A01.

The determination of the phytohormone abscisic acid (ABA) in needles of fir (Abies alba Mill.) is difficult due to the small amount of ABA and the large volume of phenolic and terpenoic compounds, which have similar structures compared with ABA. The quantitative analysis of ABA in purified extracts was not possible by HPLC because of deficient separation. A qualified method for exact quantification is gas chromatography using an electron capture detector. In this way ABA was completely separated from all other substances. Starting from the question, whether the content of secondary plant products of needles of Picea abies (L.) Karst. is influenced by damage, spruces from Wank Mountain were analysed. The needle concentrations of different compounds were influenced significantly by the class of damage as well as by the level of altitude. (orig.).

29229 (Juel–2326) **Quantitative investigations of NO_2-uptake by plants - construction of an exposition system and results with sunflowers (Helianthus annuus L.).** Latus, C. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Radioagronomie; Bonn Univ. (Germany, F.R.). Nov 1989. 103p. (In German). Order Number DE90773652. Available from NTIS (US Sales Only), PC A06/MF A01.

The present work provides a contribution towards answering the question in which way the NO_2-N supply in this low atmospheric concentration range is utilized. The aim of the investigation was therefore to determine experimentally the nitrogen uptake from the NO_2 in the air by the parts of the plant above ground with the NO_2 concentrations realistically occurring in the atmosphere. Therefore a cylindrical exposure chamber with a volume of 164 l was constructed. It was then installed in a growth chamber so that reproducible temperature and illumination conditions could be ensured. The NO_2 nitrogen in the plant was studied with the stable-isotope-measuring-technique on the basis of ^{15}N as the tracer. The air fed in was therefore purified from natural NO_2, and $^{15}NO_2$ was added in controlled doses. During the period of plant exposure, the temperature, light intensity and relative atmospheric humidity were conditioned in the chamber. Sunflowers (Helianthus annuus giantheus) served as the experimental plants. One plant each was placed into the exposure chamber at the age of 20 to 30 days. After an adaptation period of 1 day, $^{15}NO_2$ was fed into the incoming air. The NO_2 uptake was measured by two independent methods. The studies have shown that at realistic NO_2 concentrations sunflowers take up NO_2 and incorporate it into their biomass. Even during NO_2 exposure in the dark phase, reduction equivalents are made available by the plant, which reduce the NO_2 supplied to ammonium and convert it into an organic bond. At the time of harvesting, immediately after NO_2 exposure, 84% of the absorbed NO_2-N was localized in organic compounds and 16% in the ammonium fraction. The NO_2 concentrations had no influence on the exchange of other gases between the plant and atmosphere. (orig./MG).

29230 (KFK–4514) **Studies in uptake and turnover of tritiated water vapour (HTO) by vegetables.** Roller, M. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Hauptabteilung Sicherheit; Stuttgart Univ. (Germany, F.R.). Fakultaet 7 - Geo- und Biowissenschaften. Feb 1989. 141p. (In German). Order Number DE90773642. Available from NTIS (US Sales Only), PC A07/MF A01.

The aerial parts of vegetables were exposed to tritiated water vapour for up to three days in a plant growth chamber. The species used were Raphanus sativus L., Phaseolus vulgaris K. and Daucus carota L. (red radish, bean and carrot). The increase of specific activity of tissue free water as collected by freeze drying which was observed in the aerial parts of plants is explained by direct uptake of tritiated water vapour by the exposed part of the plant. It shows different characteristics for the several organs. No translocation of water from the laminae into other parts of the plant was observed. After combustion of dry matter tritium activity was detectable in the oxidation water for all parts of the plants. Kinetics of the specific activity of organically bound tritium in leaves can be described by a single curve. The lower - steep - part of the curve is increasing approximately with the uptake rate of HTO; this is explained by reversible binding of tritium by isotopic exchange reactions. The upper - flat - part of the curve represents tritium bound by light dependent reducing reactions of photosynthesis; it is increasing with a rate similar to the growth rate of leaves. (orig./KG).

29231 (PB–90-132564/XAB) **Identification of SARA (Superfund Amendments and Reauthorization Act) compounds in adipose tissue. Final report, August 1988-August 1989.** Onstot, J.D.; Stanley, J.S. Midwest Research Inst., Kansas City, MO (USA). 31 Aug 1989. 139p. (MRI–8862-A). Available from NTIS, PC A07/MF A01.

The National Human Adipose Tissue Survey (NHATS), administered by EPA/OTS, is an on-going chemical monitoring network designed to detect levels and prevalences of toxic substances in the adipose tissue of the general U.S. population. Adipose specimens collected in fiscal year 1982 were analyzed as composites for volatile and semivolatile organic compounds via HRGC/MS as part of a previous effort. The data files were then processed to determine the occurrence of compounds selected from the Superfund

Amendments and Reauthorization Act (SARA) Title III Toxic Chemical Listing, and from the SARA Section 110 CERCLA listing of 100 hazardous substances. A total of 61 volatile and 120 semivolatile target compounds were selected for analysis from the listings based on their predicted suitability to the analytical method. Application of target compound analysis (TCA) to 46 composited adipose tissue samples resulted in the identification of 13 volatile and 19 semivolatile compounds. Frequency of occurrence data was compiled with respect to three age groups, four census regions and nine census divisions.

29232 (PB–90-153552/XAB) **Cumulative asbestos exposure and forced vital capacity.** Ayer, H.; Burg, J. Cincinnati Univ., OH (USA). Dept. of Environmental Health. 1975. 21p. Available from NTIS, PC A03/MF A01.

Part of the data from a retrospective study of asbestos (1332214) textile workers was used to relate loss in forced vital capacity (FVC) to cumulative asbestos exposure. Using occupational histories and the results of air sampling analyses, estimates of individual cumulative asbestos fiber exposures were made for asbestos textile workers. Only those workers with more than 10 years of exposure were included in the analysis. The patterns of exposure in the production workers indicated high exposures in the 1930s, dramatic reductions in the late 1930s to early 1940s, and some further reduction to about 1950 with little change thereafter to the conclusion of the study. A relationship was developed between the ratio of the observed FVC to predicted FVC and the logarithm of exposure by linear regression. Tests were also made using office workers in the same textile facility. Weavers and yarn production workers had FVCs which were less than the predicted values and less than those of the office workers. A progressive effect was noted of asbestos dust exposure on FVC. Each doubling of cumulative asbestos fiber exposure above 100 fiber years/cubic centimeter resulted in a loss of 5 to 10% in FVC.

29233 (PB–90-153776/XAB) **NIOSH (National Institute for Occupational Safety and Health) testimony to DOL (Department of Labor) on benzene and leukemia: An epidemiologic risk assessment to the Occupational Safety and Health Administration by J. D. Miller, August 9, 1985.** Rinsky, R.A.; Smith, A.B.; Hornung, R.; Filloon, T.G.; Young, R.J. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 9 Aug 1985. 47p. Available from NTIS, PC A03/MF A01.

In the testimony, the mortality experience of a cohort with occupational exposure to benzene (71432) was updated to learn more about a possible connection to leukemia. Job/exposure matrices were used to derive cumulative exposure concentrations. The matrices were based on available air sampling data. The standardized mortality ratio (SMR) for leukemia was 328 and the SMR for multiple myeloma was 298. SMRs for leukemia increased from 105 in workers with less than 40 part per million years (ppm/y) cumulative exposure to 314 in workers with from 40 to 199.99 ppm/y; to 1,757 in those with from 200 to 399.99 ppm/y; and to 4,535 in those with 400 ppm/y or more. A 40-year working lifetime exposure at 10 parts per million was equivalent to a cumulative benzene exposure of 400 ppm/y. When the boundaries of the exposure categories were varied, this strongly positive trend in SMRs remained evident. A conditional logistic regression was performed to examine the shape of the exposure/response relation. A log linear model best explained the association between cumulative benzene exposure and leukemia. It was calculated from the model that protection against benzene induced leukemia will be increased exponentially by any reduction in the permissible exposure limit.

29234 (PB–90-153800/XAB) **NIOSH (National Institute for Occupational Safety and Health) comments to DOL (Department of Labor) to the Occupational Safety and Health Administration regarding the update of the NIOSH criteria document on beryllium by J. F. Finklea, December 10, 1975.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 10 Dec 1975. 10p. Available from NTIS, PC A02/MF A01.

The testimony presented concerns the development of a standard for controlling occupational exposures to beryllium (644017). Attention was given to the entire issue of beryllium's carcinogenic potential. The testimony was a follow-up to earlier communication and supplied information requested. The information included a review of not only new information, but also a gathering of older information to put into more proper perspective the entire issue of the carcinogenic potential of the element. Analysis of the information available indicated that beryllium does pose a carcinogenic risk to man, so that occupational exposures should be reduced to a minimum through engineering and/or personal protective controls. An evaluation was also attached of the currently available sampling and analytical methods. A question was raised over the correctness of results of analysis of volatile beryllium compounds due to possible sampling errors. While it was not felt that this concern at present was serious enough to delay the institution of the standard, NIOSH will provide additional information on the problem as it becomes available.

29235 (PB–90-154709/XAB) **Oxygen free radicals in pulmonary fibrosis. Final report.** Shatos, M.A.; Mossman, B.T. Vermont Univ., Burlington, VT (USA). Dept. of Pathology. 17 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

Studies conducted in the areas of lung cells, asbestos and oxygen free radicals were summarized. The research resulted in considerable experience in lung cell culture development, the processing of an antisera to the antioxidant enzymes superoxide-dismutase (SOD) and glutathione-peroxidase, and the completion of several studies which indicate that asbestos-induced injury to lung cells in vitro and in vivo may be mediated by oxygen free radicals. Studies related to the development of the antiserum to SOD demonstrated the involvement of active oxygen species as mediators of injury by long asbestos fibers to the cells of the respiratory tract. Other studies demonstrated the unsuccessful phagocytosis of long fibers of asbestos coupled with the generation of oxygen free radicals which might explain the increased pathogenic potential of long fibers in asbestos associated diseases of the respiratory tract. Studies were also reviewed which focused on the possible role of oxygen free radicals on asbestos associated injury in normal lung fibroblasts, a target cell in pulmonary fibrosis. Studies were conducted which resulted in the confirmation of the importance of active oxygen species in asbestos-related lung injury and suggested the possible future use of a novel therapeutic approach to clinical asbestosis.

29236 (PB–90-155896/XAB) **Asbestos-related disease: A community epidemic in the making.** Lemen, R.A.; Selikoff, I.J.; Hurst, G.A.; Wagoner, J.K. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Field Studies and Clinical Investigations. 1990. 7p. Available from NTIS, PC A02/MF A01.

The importance of epidemiological assessments in tracing the development of disease among workers was demonstrated in the report concerning the exposure of workers to asbestos (1332214) particles. A field survey made at a thermal pipe insulation facility in the southwestern portion of the United States measured airborne asbestos concentrations of 15 to 20 times the current standard. A significant number of workers employed for less than 10 years at this site demonstrated symptoms and signs consistent with asbestos-related diseases. Potential for community exposure was also great. Prior to the opening of this facility in the southwest, its predecessor was operating in the northeastern United States from the early 1940s through 1954. A study of a 900 member cohort of former employees at this earlier site was completed and demonstrated a highly significant excess of asbestos related diseases, malignant and nonmalignant in nature. A study of family members living with the worker at the time of employment, indicated that 50% of these family members had x-ray abnormalities consistent with asbestos-related disease. Other reports indicating that asbestos-related diseases were not limited to the worker were cited as well.

29237 (PB–90-155904/XAB) **Epidemiology of asbestos-related diseases.** Dement, J.M. National Inst. for Occupational Safety and Health, Morgantown, WV (USA). Div. of Respiratory Disease Studies. Jul 1981. 49p. Available from NTIS, PC A03/MF A01.

Although there were several anecdotal reports from earlier times, the first well documented case of asbestosis was reported in 1906 in a worker engaged in the production of asbestos textiles. In 1917 a report of ten cases of pulmonary fibrosis occurring at a Pennsylvania facility was published. The first detailed epidemiologic study of asbestos workers was undertaken in Great Britain in 1928. The first indication that asbestos might be a human carcinogen came in

1935 with the report of three independently diagnosed cases of lung cancer detected during autopsy of asbestos workers. Epidemiologic studies have now repeatedly demonstrated an association between asbestos exposure and increased mortality due to asbestosis, lung cancer, pleural and peritoneal mesothelioma, and gastrointestinal cancer. In some studies asbestos exposure has also been associated with increased risks for laryngeal cancer and cancer of the buccal cavity and pharynx. Studies which have been concerned with exposure to crocidolite, amosite, anthophyllite, tremolite, and chrysotile were highlighted. Other topics reviewed included asbestos contamination of other minerals, the combined effects of asbestos exposure and tobacco smoke, mortality and pleural radiographic changes, and mixed fiber exposures.

29238 (PB–90-155920/XAB) **Spray application of fireproof insulation at the construction site of the Proctor and Gamble Technical Center, Blue Ash, Ohio.** Lemen, R.A. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Field Studies and Clinical Investigations. 15 Aug 1972. 7p. Available from NTIS, PC A02/MF A01.

Worker exposures to asbestos during application of fireproofing insulation materials at the Proctor and Gamble site in Blue Ash, Ohio were examined. Personal membrane filter sampling devices were placed on four workers involved in the spraying and mixing operation. During the spraying operation, each of the four workers became literally covered with the sprayed-on material. Buildings, grounds, and everything within a 50-foot radium of the spray unit were also covered. Only the mixer pump operator was furnished with a respirator which he was not wearing when observed. The workers took their work clothing home at the end of the day. Even though the exposure to the workers was below the standard at the time of wet spraying, increased exposures were possible to the mixer pump operator when opening the bags with the asbestos-containing material, and also after the sprayed-on material had dried and was being cleaned up around the area of spraying by dry sweeping. Respirators should be supplied to all workers spraying or cleaning up or working around the asbestos-containing material. Clothing and laundering should be provided by the company doing the spraying. The use of hanging tarpaulins was suggested to prevent the spread of the materials outside the spraying area. Materials not containing asbestos should be substituted.

29239 (PB–90-155938/XAB) **In depth survey report of Carolina Freight Carriers, Carlisle, Pennsylvania, and York, Pennsylvania.** Zaebst, D.D. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Surveillance, Hazard Evaluation and Field Studies. Sep 1989. 50p. (IWS–146.17). Available from NTIS, PC A03/MF A01.

An in-depth study was made of worker exposures to diesel exhaust as part of a case/control mortality and industrial hygiene study of truck drivers, dock workers and mechanics presumably exposed to this aerosol in the course of their jobs. Samplings were taken at the Carolina Freight Carriers Terminal located in Carlisle and York, Pennsylvania. Measurements of elemental carbon taken during mild weather conditions indicated exposures only slightly above ambient highway concentrations of 3.8 micrograms/cubic meter (microg/cu m) in most jobs. Geometric mean exposures to submicrometer elemental carbon ranged from 5.5 microg/cu m in dock workers using gas powered tow motors to 8.9 microg/cu m in road drivers driving road tractors equipped with horizontal exhaust systems. The geometric mean exposures to elemental carbon in all jobs were significantly higher than the geometric mean ambient concentration of 0.75 microg/cu m measured in a residential area of Harrisburg. Only very low or nondetectable levels of other components such as nitrogen oxides, respirable particulates, polycyclic aromatic hydrocarbons or nitro substituted polycyclic aromatic hydrocarbons were reported from this sampling. Those which were detectable were far below allowable levels.

29240 (PB–90-155953/XAB) **Chrysotile asbestos in industry.** Wallingford, K.M. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Surveillance, Hazard Evaluation and Field Studies. 23 Feb 1978. 22p. Available from NTIS, PC A03/MF A01.

The six major forms of asbestos were reviewed and then the most widely used form, chrysotile, was examined in more detail. The three largest industries using chrysotile include the asbestos/cement pipe industry, the asbestos friction products industry, and the asbestos textiles industry. A discussion was given for the production operations and products made in each of these industries. A brief comparison was included of the optical and electron microscopy techniques used in asbestos exposure evaluation. The United States Public Health Service, in 1964, initiated a comprehensive industrial hygiene study of these three industries to characterize the exposures to chrysotile asbestos and to establish new sampling and analytical methods. Some recent research based on samples collected during the study was reviewed as well. In comparing the usefulness of phase contrast microscopy and electron microscopy, it was determined that the phase contrast microscopy technique provided relatively good indications of asbestos fibers greater than 5 micrometers in length.

29241 (PB–90-161852/XAB) **Health-hazard evaluation report HETA 88-156-1984, Georgia Gulf Corporation, Tiptonville, Tennessee.** Calvert, G.M.; Mathias, C.G.T. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Aug 1989. 27p. (HETA–88-156-1984). Available from NTIS, PC A03/MF A01.

The Georgia Gulf Corporation, Tiptonville, Tennessee, was investigated because of an outbreak of dermatitis. The facility produced polyvinyl-chloride compound by blending polyvinyl-chloride resin with other ingredients. Rashes were reported by 22 production workers and three clerical or management workers. Examination of seven of the workers indicated that all of them appeared to have contact dermatitis. Rashes were found in areas of the body where powders may come in contact with the body, and the rashes improved when away from work. Blender operators had a significantly elevated risk of developing dermatitis compared with production workers who had lower exposures to dusts and powders. The report concludes that the dermatitis was probably of occupational origin, due to exposure to airborne pigment powders and acrylic polymers containing residual monomers. The report recommends measures to reduce exposures and prevent dermatitis, including showering at the end of a work shift that involved exposure to dusts and powders, reduction of airborne dust levels through engineering controls, and the use of protective clothing, barrier creams, and skin moisturizers.

29242 (PB–90-162470/XAB) **NIOSH (National Institute for Occupational Safety and Health) manual of analytical methods (Third edition). Third supplement.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Physical Sciences and Engineering. 15 May 1989. 222p. Available from NTIS, PC A10/MF A02.

See also PB–88-204722.

This supplement contains 34 methods of analysis for 69 toxic chemical compounds and serves as an update to the NIOSH manual of analytical methods. Methods were selected on the basis of their use, input from the clients and NIOSH chemists on need for change, and the health implications of the compounds. Methods were included for acetaldehyde, acetic-acid, acrylonitrile, aldehydes, aliphatic amines, aminoethanol compounds, asbestos bulk and fibers, 1-butanethiol, chlordane, hexavalent chromium compounds, cyanuric-acid, ethyleneamines, endrin, fibers, formaldehyde, furfuryl-alcohol, glutaraldehyde, hydrogen-cyanide, isocyanates, ketones, mercury, methyl-methacrylate, nitrosamines, pentachlorophenol, quartz in coal mine dust, ribavirin respirable crystalline silica, sulfur-dioxide, toluene diamines, and valeraldehyde.

29243 (PB–90-163676/XAB) **National occupational-health survey of mining asbestos report.** National Inst. for Occupational Safety and Health, Morgantown, WV (USA). Div. of Respiratory Disease Studies. 4 Feb 1988. 82p. Available from NTIS, PC A05/MF A01.

The report concerned the results of surveys of four asbestos mines (SIC-1499) which were visited during May, June and July of 1984. The data collected were related to occupational health program and policy information in place at these facilities; an inventory of all health-related substances found on mine property; and a series of worksite observations detailing potential exposures to chemical and physical agents. The report identified potential exposures and provided the associated numbers of workers, the

occupations of those workers, and the locations on the mine property where the potential exposures were observed. The information was categorized into seven tables: four concerning chemical agents; one concerning musculoskeletal overload conditions; one physical exposure conditions; and one welding processes. Estimated annual usage information was provided for chemical substances, both generic and tradenames. Several other types of data were also gathered including laboratory analyses of a portion of the bulk dust taken from several locations at each operation.

29244 (PB–90-163700/XAB) **National occupational-health survey of mining boron minerals report.** National Inst. for Occupational Safety and Health, Morgantown, WV (USA). Div. of Respiratory Disease Studies. 18 Oct 1988. 201p. Available from NTIS, PC A10/MF A02.

The report concerned occupational health data for boron minerals mining (SIC-1474) based on surveys during June and July of 1984. Four boron minerals facilities were surveyed and data collected concerning occupational health program and policy information; the presence of all health related substances found on mine property; and a series of worksite observations which detail potential exposures to chemical and physical agents. The report identified potential exposures and provided the associated numbers of workers, the occupations of those workers, and the locations on the mine property where the potential exposures were observed. This information was categorized into seven tables: four concerning chemical agents; one concerning musculoskeletal overload conditions; one concerning physical exposure conditions; and one concerning welding processes. Estimated annual usage information was provided for chemical substances, both generic and tradenames.

29245 (PB–90-163742/XAB) **Mechanisms of cytoskeletal injury by heavy metals.** Perrino, B.A. Boston Univ., MA (USA). School of Medicine. 22 Jun 1989. 6p. Available from NTIS, PC A02/MF A01.

The major aim of the study was to determine whether metallothionein (MT) disassembly and inhibition of assembly caused by cadmium, mercury, and lead in cultured 3T3 cells was due to binding to tubulin sulfhydryl groups or binding to and activation of CaM. Methylmercury was used as a model for adverse effects to MT due to tubulin sulfhydryl binding in the extracted cytoskeleton model system and during the polymerization of purified MT proteins in vitro. The results indicated that, like calcium, the inhibitory effect of cadmium on the polymerization of purified MT proteins containing tubulin and microtubule associated proteins was enhanced by exogenously added CaM, suggesting that microtubule associated proteins were involved in mediating the sensitivity of MT to cadmium activated CaM. The findings that cadmium, like calcium, can support the binding of CaM to tubulin and MAPs in Western blots of purified MT proteins support the proposal that MAPs are important to the increased sensitivity of MT to cadmium activated CaM. The stimulation by cadmium or calcium/CaM dependent protein-kinase-II, resulting in MAP phosphorylation and MT disassembly and inhibition of assembly was not investigated.

29246 (PB–90-164047/XAB) **Bioremediation of contaminated surface soils.** Sims, J.L.; Sims, R.C.; Matthews, J.E. Environmental Protection Agency, Ada, OK (USA). Robert S. Kerr Environmental Research Lab. Aug 1989. 28p. (EPA–600/9-89/073). Available from NTIS, PC A03/MF A01.

Biological processes, including microbial degradation, have been identified as critical mechanisms for attenuating organic contaminants during transit through the vadose zone to the groundwater. On-site soil remedial measures using biological processes can reduce or eliminate groundwater contamination, thus reducing the need for extensive groundwater monitoring and treatment requirements. On-site remedial systems that utilize the soil as the treatment system accomplish treatment by using naturally occurring microorganisms to treat the contaminants. Treatment often may be enhanced by a variety of physical/chemical methods, such as fertilization, tilling, soil pH adjustment, moisture control, etc. The development of a bioremediation program for a specific contaminated soil system includes: (1) a thorough site/soil/waste characterization; (2) treatability studies; and (3) design and implementation of the bioremediation plan. Biological remediation of soils contaminated with organic chemicals has been demonstrated to be an alternative treatment technology that can often meet the goal of achieving a permanent clean-up remedy at hazardous waste sites.

29247 (PB–90-164807/XAB) **Control technology for ethylene oxide sterilization in hospitals.** Mortimer, W.D.; Kercher, S.L. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Physical Sciences and Engineering. Sep 1989. 182p. (DHHS/PUB/NIOSH–89-120). Available from NTIS, PC A09/MF A01.

Errata sheet inserted.

The report examines control methods and systems for EtO sterilization in hospitals. Nine sterilizer control systems were evaluated in eight hospitals during week-long, in-depth surveys. Three emission sources typically account for most of the EtO routinely released into the work environment. First, most of the EtO gas mixture from the chamber is released to the indoor atmosphere at the air gap located at the connection of the drain to the outlet of the water sealed vacuum pump. Second, the opening of the sterilizer door at the completion of the cycle may result in a very short high exposure to the sterilizer operator followed by an increase in the workroom EtO concentration. Third, the load transfer procedure provides the closest contact with EtO for .the sterilizer operator: pulling the load from the sterilizer, transporting the load to the aerator, and inserting the load into the aerator. EtO exposures from hospital sterilizers can be controlled to not exceed a ceiling limit of 5 ppm and to average less than 0.1 ppm for a full shift.

29248 (PB–90-168980/XAB) **Hazard and operability study of an ethylene oxide sterilizer for National Institute for Occupational Safety and Health. Final report.** National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Dec 1988. 78p. (ECTB–146-20B). Available from NTIS, PC A05/MF A01.

A hazard and operability (HAZOP) study was conducted on a sterilizer supplied by compressed gas cylinders of ethylene-oxide (EtO). The sterilizer installation, equipment, and operational procedures were reviewed, and recommendations were developed both specifically for the studied installation and for the generic installation. The sterilizer consisted of a jacketed chamber and associated pumps, pipes, filters, valves and other equipment. Sterilizer facility design, sterilizer equipment design, leak monitoring, system utilities, equipment maintenance, and operational procedures were discussed. These recommendations should provide guidance to hospitals installing EtO sterilizers. The study also showed how the HAZOP study procedures which are typically used in large chemical facilities can be used on a small scale setting. The HAZOP study involved evaluating the facility as a series of systems. Log sheets of information gathered were included in the report. A process diagram of an EtO sterilizer was included along with a schematic of EtO piping from tanks to sterilizer, a schematic of EtO sample line, calibration gas line, and carrier gas line, and schematics of the air inlet line to chamber and the piping from EtO tank to supply valve.

29249 (PB–90-860891/XAB) **Urea/phenol/melamine formaldehyde polymeric resins. January 1970-February 1990 (A Bibliography from the NTIS data base). Report for January 1970-February 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 137p. Available from NTISPC N01/MF N01.

Supersedes PB–88-869029.

This bibliography contains citations concerning characteristics, safe use regulations and standards, and applications of formaldehyde polymeric resins. Modelling, test procedures, and test results for identifying the hazards of formaldehyde resin system emissions are presented. Methods of preparation and modification of formaldehyde foams for use in the building industry are included. Corrosion of formaldehyde polymeric foam thermal insulation, crosslinking and catalysis of phenol-formaldehyde polymer concrete, and urea-formaldehyde waste disposal are considered. (This updated bibliography contains 238 citations, 17 of which are new entries to the previous edition.)

29250 The production of mutagens in cooked foods. Volume 7. Knize, M.G. (University of California, Livermore,CA (USA)); Shen, N H; Felton, J.S. 18p. Air Pollution Control Assoc., Pittsburgh, PA (USA) (1988). (CONF-880679–: 81. annual meeting of

Air Pollution Control Association, Dallas, TX (USA), 19-24 Jun 1988).
88-130.5.

Epidemiological evidence suggests that many human cancers are caused by dietary factors [8], but determining the causitive factors has proven difficult. The introduction of the Ames/Salmonella mutation test in l975 provided a quick way to determine mutagenic potencies of chemicals and complex mixtures. The mutagenic response is thought to be one step in cancer induction. In this review the authors compare the mutagenic profiles for fish, chicken, and beef and discuss probable precursors for formation of these mutagenic heterocyclic amines.

29251 Three phases of plant response to atmospheric CO_2 enrichment. Idso, S.B. (Water Conservation Laboratory, Phoenix, AZ (USA)). *Plant Physiology (USA),* 87(1): 5-7 (May 1988).

Several years of research on seven different plants (five terrestrial and two aquatic species) suggest that the beneficial effects of atmospheric CO_2 enrichment may be divided into three distinct growth response phases. First is a well-watered optimum-growth-rate phase where a 300 parts per million increase in the CO_2 content of the air generally increases plant productivity by approximately 30%. Next comes a nonlethal water-stressed phase where the same increase in atmospheric CO_2 is more than half again as effective in increasing plant productivity. Finally, there is a water-stressed phase normally indicative of impending death, where atmospheric CO_2 enrichment may actually prevent plants from succumbing to the rigors of the environment and enable them to maintain essential life processes, as life ebbs from corresponding ambient-treatment plants.

29252 Patterns of stable carbon isotope discrimination ($\delta^{13}C$) in pinus taeda as a function of ozone stress. Taylor, G.E. Jr. (Oak Ridge National Lab., TN (USA)); Gunderson, C.A.; Edwards, N.T. *Plant Physiology, Supplement (USA),* 89(4): 129 (Apr 1989).

This research tested the hypothesis that ozone stress shifts the isotopic composition of carbon ($\delta^{13}C$) in needles of Pinus taeda L. (loblolly pine) seedlings grown under realistic field conditions using open top chambers. Three different ozone exposure regimes were maintained for two growing seasons. At the end of the second year, foliage exhibited two statistically significant patterns in $\delta^{13}C$ values: (1) a decrease (more negative) from -24.86 to -28.16 per mil with needle age and (2) an increase from -27.15 to -25.95 per mil with increasing ozone stress. Whereas all needle age classes exhibited the same response as a function of ozone stress, the most pronounced shift in $\delta^{13}C$ was in the youngest age class. In conjunction with intensive gas-exchange studies, the direction and magnitude of the shift in response to ozone indicates that the pollutant's effects on foliar gas-exchange processes are greater on stomatal physiology than on carbon dioxide assimilation. Consequently, it is proposed that one of the seasonally integrated effects of elevated levels of ozone stress on foliage of P. taeda is lower stomatal conductance to water vapor and thus more efficient water use. An untested corollary is that seedlings grown at ambient levels of ozone stress are more susceptible to drought than their counterparts grown at elevated levels of ozone.

29253 Responses to heat shock, arsenite and cadmium in soybean. Edelman, L. (Dept. of Energy, East Lansing, MI (USA)); Key, J.L. *Plant Physiology, Supplement (USA),* 89(4): 133 (Apr 1989).

Heat shock (HS), arsenite (As) and cadmium (Cd) treatments induced the HS response in soybean seedlings but differed in their abilities to induce stress tolerance. Pretreatment of seedlings with sub-lethal HS protected them from subsequent normally lethal HS treatment. However, the protection was much more pronounced in 1 day-old than in 2 day-old plants. Sublethal arsenite pretreatment resulted in only a low level of protection against lethal As or HS treatment and severe damage still occurred in specific tissues. Cadmium did not induce any self- or cross-protection. DNA sequence analyses revealed that HS, As and Cd induced the transcription of similar sequences. However, Northern blot analyses of HS mRNAs, and analyses of in vitro translation products and in vivo-labeled proteins by 1D and 2D SDS-PAGE demonstrated that, compared to HS, the response to the chemical stresses was slower, less intense and not as selective. Apparently any causal relationship between HS proteins and induced stress tolerance must also involve developmental-, tissue-, and/or quantitative-specificities.

29254 Regulation of poly(gamma-glutamycysteinyl)glycine synthesis. Robinson, N.J. (Univ. of Durham (England)); Lindsay, W.P.; Delhaize, E.; Berger, J.M.; Jackson, P.J. *Plant Physiology, Supplement (USA),* 89(4): 196 (Apr 1989).

In cell lines of Datura innoxia increased synthesis of $(gammaEC)_nG$ is detected 5 min after exposure to Cd and this rapid response is largely insensitive to cycloheximide. In the absence of exogenous cysteine, glutathione pools are depleted coincident with $(gammaEC)_nG$ synthesis implying an element of regulation at step(s) in the pathway after glutathione synthetase. A variant cell line, Cd-300, accumulates Cd-$(gammaEC)_nG$ aggregates more rapidly than wild type, WDI, cells. However, initial rates of synthesis of the apopolypeptide are similar in both cell lines. Therefore, increased $(gammaEC)_nG$ synthesis in response to Cd is not regulated by product removal due to Cd-aggregate formation. However, pulse chase experiments using (^{35}S)-cysteine show that a large pool of $(gammaEC)_nG$ is unavailable for the synthesis of $(gammaEC)_{n+1}G$ following exposure to Cd. S^{2-} is also a component of some Cd-$(gammaEC)_nG$ complexes in Cd-300 cells.

29255 Sister chromatid exchange in painters recently exposed to solvents. Kelsely, K.T. (Harvard School of Public Health, Boston, MA (USA)); Little, F.F.; Little, J.B.; Baker, E.L. Jr.; Wiencke, J.K. *Environmental Research (USA),* 50(2): 248-255 (Dec 1989).

Epidemiologic studies have suggested that exposure to solvent-based materials in the painting trades is associated with an increased cancer risk. In order to determine if the solvent exposures of current union members of the International Brotherhood of Painters and Allied Tradesman (IBPAT) are associated with a genotoxic risk, we have measured the sister chromatid exchanged (SCE) frequency in their peripheral blood lymphocytes. Previous reports have shown that chronic solvent exposure of these workers dose not elevated SCE frequencies. We now report that acute exposure, estimated by number of days worked over the month prior to venipuncture, is associated with elevated SCE levels in currently smoking workers. No elevation in SCE was associated with similar recent exposure in nonsmoking, solvent-exposed painters.

29256 Cellular lead toxicity and metabolism in primary and clonal osteoblastic bone cells. Long, G.J. (Brookhaven National Laboratory, Upton, NY (USA)); Rosen, J.F.; Pounds, J.G. *Toxicology and Applied Pharmacology (USA),* 102(2): 346-361 (Feb 1990).

A knowledge of bone lead metabolism is critical for understanding the toxicological importance of bone lead, as a toxicant both to bone cells and to soft tissues of the body, as lead is mobilized from large reservoirs in hard tissues. To further understand the processes that mediate metabolism of lead in bone, it is necessary to determine lead metabolism at the cellular level. Experiments were conducted to determine the intracellular steady-state ^{210}Pb kinetics in cultures of primary and clonal osteoblastic bone cells. Osteoblastic bone cells obtained by sequential collagenase digestion of mouse calvaria or rat osteosarcoma (ROS 17/2.8) cells were labeled with ^{210}Pb as 5 microM lead acetate for 20 hr, and kinetic parameters were determined by measuring the efflux of ^{210}Pb from the cells over a ^{210}-min period. The intracellular metabolism of ^{210}Pb was characterized by three kinetic pools of ^{210}Pb in both cell types. Although the values of these parameters differed between the primary osteoblastic cells and ROS cells, the profile of ^{210}Pb was remarkably similar in both cell types. Both types exhibited one large, slowly exchanging pool (S3), indicative of mitochondrial lead. These data show that primary osteoblastic bone cells and ROS cells exhibit similar steady-state lead kinetics, and intracellular lead distribution. These data also establish a working model of lead kinetics in osteoblastic bone cells and now permit an integrated view of lead kinetics in bone.

29257 Early inhibition of photosynthesis during development of Mn toxicity in tobacco. Nable, R.O. (Univ. of Kentucky,

Lexington (USA)); Houtz, R.L.; Cheniae, G.M. *Plant Physiology (USA)*, 86(4): 1136-1142 (Apr 1988).

Early physiological effects of developing Mn toxicity in young leaves of burley tobacco (Nicotiana tabacum L. cv KY 14) were examined in glass-house/water cultured plants grown at high (summer) and low (winter) photon flux. Following transfer of plants to solutions containing 1 millimolar Mn^{2+}, sequential samplings were made at various times for the following 9 days, during which Mn accumulation by leaves increased rapidly from ≈ 70 on day 0 to ≈ 1700 and ≈ 5000 microgram per gram dry matter after 1 and 9 days, respectively. In plants grown at high photon flux, net photosynthesis declined by ≈ 20 and ≈ 60% after 1 and 9 days, respectively, and the onset of this decline preceded appearance (after 3 to 4 days) of visible foliar symptoms of Mn toxicity. Intercellular CO_2 concentrations and rates of transpiration were not significantly affected. Though the activity of latent or activated polyphenol oxidase increased in parallel with Mn accumulation, neither leaf respiration nor the activity of catalase [EC 1.11.1.6] and peroxidase [EC 1.10.1.7] were greatly affected. These effects from Mn toxicity could not be explained by any changes in protein or chlorophyll abundance. Additionally, they were not a consequence of Mn induced Fe deficiency. Therefore, inhibition of net photosynthesis and enhancement of polyphenol oxidase activity are early indicators of excess Mn accumulation in tobacco leaves.

29258 Effect of carbon dioxide enrichment on development of the first six mainstem leaves in soybean. Leadley, P.W. (North Carolina State Univ., Raleigh (USA)); Reynolds, J.F. *American Journal of Botany (USA)*, 76(10): 1551-1555 (Oct 1989).

Many conclusions concerning plant responses to CO_2 enrichment have been based on assumptions of increased leaf size derived from observations of average leaf area measured at some time well into the growth period. The objective of this study were to study the effect of elevated CO_2 on (1) the timing of mainstem leaflet appearance, (2) the rate and duration of leaflet expansion, and (3) the final area of individual leaflets of soybeans (Gylcine max [L.] Merr. cv. Bragg) grown from seed at 348, 502, and 645 μ1 1^{-1} CO_2 concentrations. Central leaflet areas from mainstem trifoliolates 1-6 were measured every two days time of appearance to full expansion. Leaflets tended to appear earlier in elevated CO_2 treatments; leaflets 2 through 6 appeared an average of 0.4 days earlier in the 502 μ1 1^{-1} treatment and 1.2 days earlier in the 645 μ1 1^{-1} treatment than in the 349 μ1 1^{-1} treatment. Relative rates of expansion were different among leaflets in their response to elevated CO_2; expansion rates of leaflets 1 and 4 were significantly higher at the highest CO_2 concentration. However, final area of leaflets was not affected by CO_2, or (in leaflet 5 only) was slightly smaller at the highest CO_2 treatment. Apparently, higher expansion rates of leaflets 1 and 4 at high CO_2 were offset by a tendency for decreased duration of expansion. It appears that there are morphological constraints on final leaflet area in soybean seedlings which limit the effects of elevated CO_2 on the early development of mainstem leaf area.

29259 Cyanide inactivation of hydrogenase from Azotobacter vinelandii. Seefeldt, L.C. (Univ. of California, Riverside (USA)); Arp, D.J. *Journal of Bacteriology (USA)*, 171(6): 3298-3303 (Jun 1989). DOE Contract FG03-84ER13257.

The effects of cyanide on membrane-associated and purified hydrogenase from Azotobacter vinelandii were characterized. Inactivation of hydrogenase by cyanide was dependent on the activity (oxidation) state of the enzyme. Active (reduced) hydrogenase showed no inactivation when treated with cyanide over several hours. Treatment of reversibly inactive (oxidized) states of both membrane-associated and purified hydrogenase, however, resulted in a time-dependent, irreversible loss of hydrogenase activity. The rate of cyanide inactivation was dependent on the cyanide concentration and was an apparent first-order process for purified enzyme (bimolecular rate constant, 23.1 M^{-1} min^{-1} for CN^-). The rate of inactivation decreased with decreasing pH. [^{14}C]cyanide remained associated with cyanide-inactivated hydrogenase after gel filtration chromatography, with a stoichiometry of 1.7 mol of cyanide bound per mol of inactive enzyme. The presence of saturating concentrations of CO had no effect on the rate or extent of cyanide inactivation of hydrogenases. The results indicate that cyanide can cause a time-dependent, irreversible inactivation of hydrogenase in the oxidized, activatable state but has no effect when hydrogenase is in the reduced, active state.

5604 Other Environmental Pollutant Effects

Refer also to citation(s) 27949

29260 (AD-A-216500/9/XAB) **Effects of pulsed and c-w (continuous-wave) 2450-MHz radiation on transformation and chromosomes of human lymphocytes in vitro. Final report, 1 October 1986-15 December 1989.** Davis, C.C. Maryland Univ., College Park, MD (USA). Dept. of Electrical Engineering. 15 Dec 1989. 52p. Available from NTIS, PC A04/MF A01.

This report describes the results of research in the following areas: Whether spontaneous or phytohemagglutinin-induced transformation of human lymphocytes in vitro is affected by exposure to continuous wave (CW) or pulsed wave (PW) 2450 MHz microwaves. It is affected -by PW in a non-thermal way. Comparison of CW and PW microwave exposure at the same average specific absorption rate (SAR) - PW is markedly different and acts in a non-heating way. Comparison of effects obtained by microwave and conventional heating needed to elevate the sample temperature by 0.5,1.0,1.5 and 2.0 C. CW microwaves and conventional heating produce the same effects, PW exposure behaves differently. An attempt is made to determine whether chromosomal aberrations are induced under the conditions of the experiment.

29261 (AD-A-216869/8/XAB) **Effects of field orientation during 700-MHz radiofrequency irradiation of rats.** Frei, M.R.; Jauchem, J.R.; Padilla, J.M. School of Aerospace Medicine, Brooks AFB, TX (USA). 1989. 9p. (USAFSAM-JA-88-67). Available from NTIS, PC A02/MF A01.

Pub. in Phsiological Chemistry and Physics and Medical NMR, Vol. 21, 65-72(1989).

Ketamine-anesthetized Sprague-Dawley rats were exposed to far-field 700-MHz continuous-wave radiofrequency radiation (RFR) in both E and H orientations. Irradiation was conducted at whole-body average specific absorption rates (SARs) of 9.2 and 13.0 W/kg (E and H, respectively) that resulted in approximately equivalent colonic specific heating rates (SHRs). Exposures were performed to repeatedly increase colonic temperature by 1 deg C (38.5 to 39.5 deg C). Tympanic, tail, left and right subcutaneous (toward and away from RFR source), and colonic temperatures, arterial blood pressure, and respiratory rate were continuously recorded. In spite of equivalent colonic SHRs and the reduced E-orientation average SAR, the right subcutaneous, tympanic, and tail SARs, SHRs and absolute temperature increases were significantly greater in E than in H orientation. The cooling rate at all monitoring sites was also significantly greater in E than in H orientation. Heart rate and mean arterial blood pressure significantly increased during irradiation; however, changer between orientations were not different. Respiratory rate significantly increased during irradiation in H, but not in E orientation. These results indicate that during resonant frequency irradiation, differences occur in the pattern of heat deposition between E- and H-orientation exposure. When compared with previous investigations performed at supraresonant frequencies, the lower level of cardiovascular change in this study was probably related to the lower periphery-to-core thermal gradient.

29262 (AD-A-217020/7/XAB) **Laser hazards bibliography. Report bibliography.** Sliney, D.H.; Robinson, A. Army Environmental Hygiene Agency, Aberdeen Proving Ground, MD (USA). 31 Oct 1989. 236p. Available from NTIS, PC A11/MF A02.

No abstract available.

29263 (PB-90-161324/XAB) **Protection of DOD (Department of Defense) personnel from exposure to radiofrequency radiation. Instruction.** Anderson, J. Office of the Assistant Secretary of Defense (Force Management and Personnel), Washington, DC (USA). 20 Aug 1986. 15p. (DOD-I-6055.11). Available from NTIS, PC A03/MF A01.

The Instruction supplements Department of Defense (DoD) Directive 1000.3 and DoD Instruction 6055.8 to establish a uniform personnel protection policy for exposure to radiofrequency radiation resulting from Department of Defense operations.

57 HEALTH AND SAFETY

Refer also to citation(s) 28146

29264 (CEA-CONF–9961) **Declarative modeling for process supervision.** Leyval, L. (CEA Etablissement de la Vallee du Rhone, 30 - Bagnols-sur-Ceze (FR)); Feray Beaumont, S.; Gentil, S. CEA Etablissement de la Vallee du Rhone, 30 - Bagnols-sur-Ceze (France); CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Genie Radioactif. 1989. 14p. (CONF-8907187–: IFAC: international symposium on advanced nformation processing in automatic control, Nancy (France), 3-7 Jul 1989). Order Number DE90773409. Available from NTIS (US Sales Only), PC A03/MF A01.

Our work is a contribution to computer aided supervision of continuous processes. It is inspired by an area of Artificial Intelligence: qualitative physics. Here, supervision is based on a model which continuously provides operators with a synthetic view of the process; but this model is founded on general principles of control theory rather than on physics. It involves concepts such as high gain or small time response. It helps in linking temporally the evolution of various variables. Moreover, the model provides predictions of the future behaviour of the process, which allows action advice and alarm filtering. This should greatly reduce the famous cognitive overload associated to any complex and dangerous evolution of the process.

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Refer also to citation(s) 27529, 27530, 27684, 27698, 27723, 27725, 27733, 27734, 28146, 28189, 28190, 28554, 28646, 28680, 29101

29265 (JINR–E6-89-725) **Investigations of the separation of Np, Pa, U, Th and REE in geological samples.** Gleisberg, B.; Ly, B.M.; Gorski, B. Joint Inst. for Nuclear Research, Dubna (USSR). [1989]. 18p. Sponsored by Joint Institute for Nuclear Research. (CONF-8909225–3: Actinides '89, Tashkent (USSR), 24-29 Sep 1989). Order Number DE90009783. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; JINR, Publishing Dept., Head Post Office, P.O. Box 79101000, Moscow, USSR.

The quantitative determination of trace amounts of Th, U and REE in very depleted rocks is necessary to get information about genetic processes in the investigated area. U, Th and REE are used as geochemical indicators. We treated two types of geological samples which differ considerably in their origin and in the U, Th, REE contents. It is clear that the analytical methods and chemical separation procedures should be very different for these two types of materials. Two different schemes of separation were tested and compared: Cation exchange and solvent extraction and extraction chromatography. To estimate the suitability of the described separation schemes for the determination of REE in types of samples being rich in U or Th but poor in REE and thus demanding separation from U Or Th before irradiation, the behavior of U and Th is presented in this paper as well. 8 refs., 7 figs., 5 tabs.

29266 (LA-UR–90-51) **Hydro-thermo-mechanical response of a fractured rock block.** Kelkar, S.; Zyvoloski, G. Los Alamos National Lab., NM (USA). [1990]. 8p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-36. (CONF-900646–8: 31. US symposium on rock mechanics, Golden, CO (USA), 18-20 Jun 1990). Order Number DE90008460. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Hydro-thermo-mechanical effects in fractured rocks are important in many engineering applications and geophysical processes. Modeling these effects is made difficult by the fact that the governing equations are nonlinear and coupled, and the problems to be solved are three dimensional. In this paper we describe a numerical code developed for this purpose. The code is finite element based to allow for complicated geometries, and the time differencing is implicit, allowing for large time steps. The use of state-of-the-art equation solvers has resulted in a practical code. The code is capable of fully three dimensional simulations, however, in this paper we consider only the case of two dimensional heat and mass flow coupled to one dimensional deformation. Partial verification of the code is obtained by comparison with published semianalytical results. Several examples are presented to demonstrate the effects of matrix expansion, due to pore pressure and heating, on fracture opening due to fluid injection. 16 refs., 11 figs.

29267 (LA-UR–90-99) **Liquifaction of fluid saturated rocks due to explosion-induced stress waves.** Dey, T.N.; Brown, J.A. Los Alamos National Lab., NM (USA). [1990]. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-900646–7: 31. US symposium on rock mechanics, Golden, CO (USA), 18-20 Jun 1990). Order Number DE90006481. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Shock-induced liquefaction of a water-saturated rock may occur during the passage of a large amplitude stress wave, such as that due to an explosive. We studied this phenomena numerically with the aid of a material model which incorporates effective stress principles, and experimentally with a gas gun. Our numerical model is capable of calculating material response for both small and large deformation and any initial saturation. Phase transitions of the solid phase and the water phase are also allowed. Fitting the model to dry gas gun experiments allowed reasonable predictions of nearly saturated experiments. Liquefaction, the loss of shear strength when pore pressure exceeds the mean stress, appears to occur during the unloading portion of these experiments. The pore crushing which occurs, even under fully saturated conditions, leads to greater attenuation of a stress wave, as well as liquefaction of the rock and a lengthening of the wave duration, as the wave passes. 12 refs., 4 figs.

29268 (LA-UR–90-721) **An anomalous wind between valleys—its characteristics and a proposed explanation.** Stone, G.L.; Hoard, D. Los Alamos National Lab., NM (USA). [1990]. 19p. Sponsored by U.S. Department of Defense. (CONF-9006111–3: 5. conference on mountain meteorology, Boulder, CO (USA), 26-29 Jun 1990). Order Number DE90008965. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Beginning in 1986, the US Army engaged the Los Alamos National Laboratory to study meteorological operations at several sites where toxic materials are stored. The main objective of the study was to develop recommendations for a system that could forecast the transport and dispersion of airborne materials in the event of an accident. In the course of that project, detailed meteorological and tracer experiments were conducted at the Army's Tooele Depot, 60 km southwest of Salt Lake City, Utah. During these investigations we observed that the direction of near-surface flow through low passes connecting two adjacent valleys is often opposite to the prevailing gradient flow. In this sense, the wind was considered "anomalous." In this paper we discuss the statistical properties of this intervalley flow and use a case study to illustrate its vertical structure in relation to the surrounding terrain and the overlying gradient flow. A simplified analysis of the thermal energy changes in the valley atmospheres is used to explain the origin of this local flow. 5 figs.

29269 (LBL–28600) **Coupled behavior of rock joints.** Tsang, Chin-Fu. Lawrence Berkeley Lab., CA (USA). Feb 1990. 35p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00098. (CONF-900640–5: International conference on rock joints, Loen (Norway), 4-6 Jun 1990). Order Number DE90009222. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The behavior of rock joints under various coupled processes is reviewed under four broad categories: hydromechanical processes, thermohydromechanical processes, hydromechanical-chemical processes, and thermomechanical-hydrochemical processes. The state-of-the-art and possible directions of further research in these coupled processes are discussed. Rock joint behaviors considered include not only dilation, closure, shear and joint propagation, but also changes in flow permeability and chemical sorption and retardation capabilities. These properties are of critical concern in practical considerations of the rock mass as a medium to store and isolate chemical and radioactive wastes. Investigations of coupled processes in two-fracture systems and multi-fracture systems are pointed out as interesting areas for future research. The need to consider coupled processes in borehole testing procedures involving rock joints is emphasized. 70 refs., 12 figs.

29270 (NAGRA-NTB–84-20) **Geoscientific bases of the exploratory site Oberbauen Stock: Volume 2: annexes.** Schneider, T.R. (Uerikon (Switzerland)); Kappeler, S.W. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Dec 1984. 39p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

This report contains a collection of geological maps of the exploratory site Oberbauen Stock. 36 figs.

29271 (NAGRA-NTB–85-10) **Exploratory boreholes Boettstein, Weiach, Riniken, Schafisheim, Kaisten, Leuggern: fluid-logging. Temperature, salinometer and spinner-flowmeter measurements: Annex volume.** Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Nov 1988. 26p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

This volume contains composite-logs of the boreholes mentioned in the title of the document. 24 figs.

29272 (NAGRA-NTB–85-10) **Exploratory boreholes Boettstein, Weiach, Riniken, Schafisheim, Kaisten, Leuggern: fluid-logging. Temperature, salinometer and spinner-flowmeter measurements: Text volume.** Kleboth, P. (Geotest AG, Zollikofen (Switzerland)). Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Nov 1988. 127p. (In German). Available from Nagra, CH-5401 Baden, Switzerland.

As part of the hydrogeological investigations in the six exploratory boreholes drilled by NAGRA in northern Switzerland until 1986, a comprehensive data collection programme aimed at the localisation and characterization of zones of increased rock permeability was carried out. Within this programme the 'Fluid Logging' campaign investigated temperature, conductivity and flow conditions of the borehole fluid column. The present report is a comprehensive collection of the most important Fluid-logging runs from all six boreholes (Boettstein, Weiach, Riniken, Schafisheim, Kaisten and Leuggern). The first part of the report presents the methodology followed and describes the operating principles of the temperature, salinometer and spinner-flowmeter tools used, the range of their application and their performance. The second part of the report details the individual logging runs for each borehole. It describes the borehole history, which is important for the interpretation of results and states the boundary conditions e.g. water level in well, pump rate, difficulties encountered etc. Results are presented as composite logs. The fluid logs are compared with the relevant geological data indicating high permeability zones and the provisional results from the numerous hydraulic tests. (author) 15 tabs., 35 figs.

29273 (NAGRA-NTB–88-14) **Inverse modeling of Chalk River block.: HYDROCOIN - level 2/case 3, level 3/case 5a.** Carrera, J. (E.T.S.I. Caminos. U.P.C., Barcelona (Spain)); Heredia, J. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Dec 1988. 124p. Available from Nagra, CH-5401 Baden, Switzerland.

Within the framework of the international project HYDROCOIN, a block of fractured monzonitic gneiss within the facilities of Chalk River National Laboratories, Canada, was selected as a test case to study and develop strategies for the calibration and validation of groundwater flow models. Adopting a quasi-three dimensional formulation, the fractures were simulated by two-dimensional finite elements and the rock mass was simulated by strings of line elements. The models were calibrated using, first, steady-state data and, second, transient data. Model calibration involved both identification of model parameters and model structure. Model parameters were obtained by automatic estimation based on measures of the model response and prior information about the model parameters. Excellent agreement between measured and computed heads was obtained for the transient runs. However, such match was only fair in steady-state. Model Structures Identification criteria were used to rank the performance of several model structures. In the steady state the model structure identification criteria did not strongly support increasing the model complexity. However, it is also believed that the information content of the steady state data was quite poor. In contrast, the transient data being both more numerous and more informative than steady-state data, allowed the model structure identification criteria to suggest more complex models. The validation runs were performed on data corresponding to interference pump tests different from the ones used for calibration. The prediction errors in these runs were relatively small and consistent with the calibration uncertainty. Furthermore, the ranking of the models performances during validation runs was the same as the one obtained at the calibration stage, using Model Structure Identification Criteria. (author) 26 figs., 17 tabs., 39 refs.

29274 (NAGRA-NTB–88-31) **Grimsel test site: radar crosshole tomography with application to migration of saline tracer through fracture zones.** Niva, B. (Swedish Geological Co., Uppsala (Sweden)); Olsson, O.; Bluemling, P. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Oct 1988. 108p. Available from Nagra, CH-5401 Baden, Switzerland.

A comprehensive radar crosshole tomography survey has been carried out at the Grimsel Rock Laboratory in order to test the radar method with respect to its capability to describe geological features and to map migration of saline tracer through difference tomography. The radar survey has provided a map of the attenuation and slowness distribution of radar waves in a planar section with the dimensions 150x225 m. The program has included measurement points along parallel boreholes and a tunnel connecting these boreholes. The slowness and attenuation tomograms give similar images of the structures at the investigated site. The largest anomalies are caused by lamprophyric dikes which are almost parallel to the boreholes while fracture zones give rise to anomalies of smaller magnitude. The attenuation tomograms have poorer resolution and contain more artifacts than the slowness tomograms. This is caused by systematic errors in the amplitude data caused by inadequate knowledge of the antenna radiation pattern for source points located in the tunnel. The transport of saline tracer was investigated by making a tomographic inversion of the difference between data collected prior to injection of saline tracer and during injection. Two such experiments were performed with different injection points. The largest concentrations of tracer were observed close to the injection points. The tracer followed fracture zones extending from the injection points. The results clearly show the capabilities of the radar method to map tracer transport through fractured rock. (author) 33 figs., 5 tabs., 14 refs.

29275 (NAGRA-NTB–89-07) **Stripa Project: interim report on the rock sealing project (stage 1).** Pusch, R. (Clay Technology (Sweden)); Boergesson, L.; Fredrikson, A.; Markstroem, I.; Erkstroem, I.; Ramqvist, G.; Gray, M.; Coons, B. Nationale Genossenschaft fuer die Lagerung Radioaktiver Abfaelle (NAGRA), Baden (Switzerland). Sep 1988. 194p. Available from Nagra, CH-5401 Baden, Switzerland.

The objective of the Sealing Project is to find new ways of sealing finely fractured rock by grouting. This requires development of new injection techniques as well as identification of materials which are sufficiently fluid to be groutable, have an acceptably low permeability and are physically and chemically stable. The present report describes the results of the first two years of investigations (Stage 1) which gave very positive results, as can be concluded from the large-scale field test. (author) 88 figs., 27 tabs., 6 refs.

29276 (SAND–89-2126C) **Surface roughness and the physical properties of fractures.** Brown, S.R. Sandia National Labs., Albuquerque, NM (USA). 1990. 9p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-900646–5: 31. US symposium on rock mechanics, Golden, CO (USA), 18-20 Jun 1990). Order Number DE90006046. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper presents a brief review of previous work on the effect of surface roughness on the physical properties of fractures. 25 refs., 7 figs.

29277 (SAND–89-2913C) **Combining acoustic emission locations and a microcrack damage model to study development of damage in brittle materials.** Holcomb, D.J.; Stone, C.M.; Costin, L.S. Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900646–3: 31. US symposium on

rock mechanics, Golden, CO (USA), 18-20 Jun 1990). Order Number DE90005195. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Under compressive stresses, brittle polycrystalline materials fail as the result of the growth, interaction and coalescence of microcracks. To predict the deformation of damaging material, constitutive laws developed for such materials must incorporate the effects of crack size, density, orientation, and interaction. A method of incorporating the accumulation and growth of microcracks into a continuum model is to use a measure of microcrack growth and interaction defined as damage. Although a number of damage theories have been proposed, there is no generally accepted experimental technique for detecting and measuring damage. Acoustic emissions (AE) have been correlated with microcrack nucleation and growth. We propose that AE locations and density are useful measures of damage that can be correlated with calculated damage. Our approach is to use acoustic emissions (AE) and computer modeling to study the development of damage in geomaterials. 7 refs., 2 figs.

29278 (UCRL–101526) **Block analysis for preliminary design of underground excavations.** Yow, J.L. Jr. Lawrence Livermore National Lab., CA (USA). Jan 1990. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900646–10: 31. US symposium on rock mechanics, Golden, CO (USA), 18-20 Jun 1990). Order Number DE90008300. Available from NTIS, PC A02/MF A01 - OSTI.

Rock mass discontinuities such as joints and faults often intersect to form discrete blocks that are individually stronger than the rock mass as a whole. When encountered during mining or construction, such blocks can cause stability problems. Displacement of the blocks around an excavation, can affect the rock mass in a hydrologic sense and in a mechanical sense. Hydrologic effects of block displacement can include the creation of preferred pathways for fluid flow or the creation of barriers to unsaturated flow of liquids. Mechanical effects occur because unhealed joints cannot support tensile stress, tend to limit the shear stress that the rock mass can carry, and reduce the rock mass stiffness locally as they open. Block theory and related analytical techniques have been developed to address problems of block identification and kinematic stability. These techniques can identify and screen potentially troublesome blocks early in the design process. Although more detailed analyses can be applied in later stages of the design effort to develop block reaction curves or to evaluate the effects of loosening around, the initial process of block identification and screening is the theme of this discussion. 12 refs., 1 fig., 5 tabs.

29279 (UCRL-ID–103499) **Recording of anomalous shear energy in the teleseismic P-wave coda at Long Valley Caldera, California, on a small aperture array.** Zucca, J.J. (Lawrence Livermore National Lab., CA (USA)); Zandt, G.; Steck, L.K.; Prothero, W A Lawrence Livermore National Lab., CA (USA). Mar 1990. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008189. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Anomalous energy in the coda of teleseismic P-waves at Long Valley caldera has been suggested to be a P to S converted arrival, perhaps with the conversion occurring at the boundaries of magma bodies beneath the caldera. We have collected new data with a small-aperture, three-component array located in the northwestern quadrant of the caldera with the purpose of testing this hypothesis. An examination of three teleseismic events using array and particle motion techniques shows that converted P- to S-waves comprise a significant fraction of the early arriving anomalous energy. In volcanic areas such as Long Valley, the scattered energy could originate at a high velocity contrast feature such as magma body interface. In addition, later arriving energy was detected with slow phase velocity and is tentatively identified as body wave to surface wave scattering. Our interpretation is illustrated with waveforms of two earthquakes from the Kuril Islands and one in northern Peru. Our results show that a small-aperture, three-component array can be used to perform detailed analysis of the coda. 12 refs., 8 figs., 1 tab.

29280 **Stoichiometry of the iron oxidation reaction in silicate melts.** Kress, V.C. (Univ. of California, Berkeley (USA)); Carmichael, I.S.E. *American Mineralogist (USA),* 73(11-12): 1267-1274 (Nov-Dec 1988).

Experiments have been performed that calibrate the stoichiometry and thermodynamics of the iron oxidation reaction in natural silicate melts. A series of experiments was carried out on six melt compositions covering a far larger range of oxygen fugacities than had been examined previously. Oxygen fugacities between air and 5.2 $\log_{10}$ units below those defined by the nickel-nickel oxide assemblage were investigated at 1360 C and 1460 C. Results of these experiments confirm that $\ln(X_{Fe_2O_3}/X_{FeO})$ is a linear function of $\ln f_{O_2}$ over this entire range, and that this linear behavior is independent of composition over the range considered. These results are inconsistent with an ideal mixing between FeO and Fe_2O_3 components. They are, however, entirely consistent with ideal mixing between FeO and $FeO_{1.464\pm0.003}$ (FeO $6Fe_2O_3$) components. A second series of experiments was performed on a single mid-ocean ridge basalt composition (JDFD2) in order to better constrain the temperature dependence of the iron oxidation reaction in this simplified two-component subsystem. This series was carried out at temperatures between 1299 C and 1636 C in air, CO_2, and 0.2 $\log_{10}$ units below the fayalite-magnetitie-quartz buffer assemblage. Results of both series of experiments were combined with the Sack et. al. (1980) and Kilinc et al. (1983) databases to estimate thermodynamic parameters for the iron oxidation reaction expressed in terms of FeO and $FeO_{1.464}$ components. These coefficients offer the most precise method available for estimation of iron oxidation state in natural silicate melts as a function of $\ln f_{O_2}$, temperature, and composition.

29281 **Particle size distributions and the sequential fragmentation/transport theory applied to volcanic ash.** Wohletz, K.H. (Earth and Space Science Division—Los Alamos National Laboratory, New Mexico (USA)); Sheridan, M.F.; Brown, W.K. *Journal of Geophysical Research (USA),* 94(B11): 15703-15722 (10 Nov 1989).

The assumption that distributions of mass versus size interval for fragmented materials fit the log normal distribution is empirically based and has historical roots in the late 19th century. Other often used distributions (e.g., Rosin-Rammler, Weibull) are also empirical and have the general form for mass per size interval: $n(l)=kl^{\alpha}\exp(-l\beta)$, where $n(l)$ represents the number of particles of diameter l, l is the normalized particle diameter, and k, α, and β are constants. We describe and extend the sequential fragmentation distribution to include transport effects upon observed volcanic ash size distributions. The sequential fragmentation/transport (SFT) distribution is also of the above mathematical form, but it has a physical basis rather than empirical. The SFT model applies to a particle-mass distribution formed by a sequence of fragmentation (comminution) and transport (size sorting) events acting upon an initial mass m': $n(x, m)=C\int\int n(x', m')p(\xi)\,dx'\,dm'$, where x' denotes spatial location along a linear axis, C is a constant, and integration is performed over distance from an origin to the sample location and mass limits from 0 to m.

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Refer also to citation(s) 29766

29282 (AD-A–216938/1/XAB) **Characteristics of cosmic infrared variable sources. Final report, 1 October 1986-30 September 1989.** Jones, T.J. Minnesota Univ., Minneapolis, MN (USA). Dept. of Physics and Astronomy. 15 Sep 1989. 52p. Available from NTIS, PC A04/MF A01.

Results of infrared photometric observations of 63 AFGL sources over the past nine years are presented. Using these data together with previous measurements of these stars, we determine pulsation periods and mean photometric characteristics. These stars are found to lie midway between classical Mira variables and the Radio Luminous OH/IR stars in their period distribution and photometric properties. For the sample as a whole, there is no evidence for sudden or transient behavior such as a switch in pulsation mode.

Rather, these stars show rapid, but continuous, evolution from shorter period Miras with weak mass loss to longer periods and larger mass loss rates. The carbon rich stars in our sample have the same period distribution as the oxygen rich stars. None of the carbon stars have periods as long as those of the very long period Radio Luminous OH/IR stars.

29283 (N-90-16596) **Reports of planetary astronomy, 1986.** National Aeronautics and Space Administration, Washington, DC (USA). Aug 1987. 129p. (NASA-TM-100776;NAS-1.15:100776). Available from NTIS, PC A07/MF A01.

A compilation of abstracts of reports from Principal Investigators funded through NASA's Planetary Astronomy Program, Office of Space Science and Applications, is presented. The purpose is to provide a document which succinctly summarizes work conducted in this program for 1986. Each report contains a brief statement on the strategy of investigation and lists significant accomplishments within the area of the author's funded grant or contract, plans for future work, and publications.

29284 (N-90-16607, pp. 1-2) **Analytical study of comet nucleus samples.** Albee, A.L. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR-184821;NAS-1.26:184821;LPI-CONTRIB-691;CONF-890195-: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Analytical procedures for studying and handling frozen (130 K) core samples of comet nuclei are discussed. These methods include neutron activation analysis, x ray fluorescent analysis and high resolution mass spectroscopy.

29285 (N-90-16607, pp. 3-4) **The origin, composition and history of cometary ices from spectroscopic studies.** Allamandola, L.J. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR-184821;NAS-1.26:184821;LPI-CONTRIB-691;CONF-890195-: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The spectroscopic analysis of pristine cometary material provides a very important probe of the chemical identity of the material as well as of the physical and chemical conditions which prevailed during the comet's history. Concerning classical spectroscopy, the spectral regions which will most likely prove most useful are the infrared, the visible and ultraviolet. Newer spectroscopic techniques which have the potential to provide equally important information include nuclear magnetic resonance (NMR) and electron spin resonance (ESR). Each technique is summarized with emphasis placed on the kind of information which can be obtained.

29286 (N-90-16607, pp. 5-7) **Experimental studies of gas trapping in amorphous ice and thermal modelling of comets: Implications for Rosetta.** Bar-nun, A. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR-184821;NAS-1.26:184821;LPI-CONTRIB-691;CONF-890195-: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The trapping of mixtures of CO, CH_4, N_2 and Ar in amorphous water ice was studied experimentally. It is shown that the ice particles could not have been formed at a higher temperature and, subsequently, cool down. Experiments where ice was deposited at elevated temperatures, then cooled down and gas was flowed into the ice, showed that the amount of trapped gas depends only on the highest temperature at which the ice was formed, or resided, prior to cooling and gas flow into it. Consequently, the cometary ice had to be formed at approx. 48 K and the ice is therefore amorphous. The thermal profile of a comet in Halley's orbit was calculated, including the build-up of an insulating dust layer. It was found that an insulating dust layer a few cm thick is enough to choke most of the water emission from the surface. A similar thermal model was calculated for comet P/Temple-1, a candidate for both CRAF and Rosetta (CNSR) missions. The temperature at a depth of 10 m is approx. 160 K for all models considered and, hence, the ice at this depth is crystalline. A crystalline ice layer 40 to 240 m thick was found to overly the gas-laden amorphous ice. Consequently, it should be difficult for the probes of the two comet missions to sample pristine amorphous ice, unless they are aimed at the bottom of an active crater.

29287 (N-90-16607, pp. 8) **On the isotope analysis of cometary dust.** Begemann, F. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR-184821;NAS-1.26:184821;LPI-CONTRIB-691;CONF-890195-: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

It is thought that comets are an intimate mixture of ices and sub-micron to pebble sized silicates. Based on experience with carbonaceous chrondrites, part of the smallest grains are expected to be primary condensates carrying the unadulterated isotopic signature of their place of origin. In order to extract this information a grain-by-grain analysis will be necessary.

29288 (N-90-16607, pp. 9-10) **Direct determination of the morphology, structure and composition of cometary and interstellar ice analogs in the laboratory.** Blake, D.F.; Allamandola, L.J. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR-184821;NAS-1.26:184821;LPI-CONTRIB-691;CONF-890195-: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Abstract Only.

Ices of various kinds (H_2O, CO, CO_2, CH_4, NH_3, CH_3OH, etc.) comprise a volumetrically significant proportion of objects in the solar system (comets, outer planets, planetary rings, satellites) as well as in interstellar space (astrophysical ices). The refinement of analytical electron microscopy (AEM) procedures for storing, preparing and analyzing ices and other materials at cryogenic temperatures is discussed. These procedures will be essential to the successful analysis of returned comet nucleus samples.

29289 (N-90-16607, pp. 11) **Electron beam analysis of particulate cometary material.** Bradley, J. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR-184821;NAS-1.26:184821;LPI-CONTRIB-691;CONF-890195-: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Abstract Only.

Electron microscopy will be useful for characterization of inorganic dust grains in returned comet nucleus samples. The choice of instrument(s) will depend primarily on the nature of the samples, but ultimately a variety of electron-beam methods could be employed. Scanning and analytical (transmission) electron microscopy are the logical choise for morphological, mineralogical, and bulk chemical analyses of dust grains removed from ices. It may also be possible to examine unmelted ice/dust mixtures using an environmental scanning electron microscope equipped with a cryotransfer unit and a cold stage. Electron microscopic observations of comet nuclei might include: (1) porosities of dust grains; (2) morphologies and microstructures of individual mineral grains; (3) relative abundances of olivine, pyroxene, and glass; and (4) the presence of phases that might have resulted from aqueous alteration (layer silicates, carbonates, sulfates).

29290 (N-90-16607, pp. 12) **Thermal and chemical processing of the outermost layer of cometary nuclei.** Campins, H. (Arizona Univ., Tucson (USA)); Krider, E.P. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR-184821;NAS-1.26:184821;LPI-CONTRIB-691;CONF-890195-: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

A non-equilibrium mechanism that may produce substantial thermal and chemical processing of the outermost layer of cometary nuclei is proposed. If this phenomenon does occur, its effects will impact the interpretation of results from the CNSR and CRAF missions.

29291 (N–90-16607, pp. 13-14) **The carbon chemistry of meteorites: Relationships to comets.** Chang, S. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The carbonaceous meteorites exhibiting alteration by liquid water bear a strong relationship to comets. Not only is their elemental composition closer to solar in relative abundances than other meteorites, they are water rich; and they contain isotopic compositions among refractory and volatile elements indicative of presolar components. Some of these isotopic anomalies occur in organic compounds and carbonaceous grains signifying the presence of discrete and identifiable carbon components derived from interstellar and circumstellar matter. Insofar as comets and meteorites are ultimately formed from interstellar gas and dust, and comets have been subjected to considerably less aqueous and thermal evolution than carbonaceous meteorites, the interstellar imprint should be much stronger and better preserved in comets.

29292 (N–90-16607, pp. 15) **Laboratory analyses of micron-sized solid grains: Experimental techniques and recent results.** Colangeli, L. (Lecce Univ. (Italy)); Bussoletti, E.; Blanco, A.; Borghesi, A.; Fonti, S.; Orofino, V.; Schwehm, G. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Morphological and spectrophotometric investigations have been extensively applied in the past years to various kinds of micron and/or submicron-sized grains formed by materials which are candidate to be present in space. The samples are produced in the laboratory and then characterized in their physio-chemical properties. Some of the most recent results obtained on various kinds of carbonaceous materials are reported. Main attention is devoted to spectroscopic results in the VUV and IR wavelength ranges, where many of the analyzed samples show typical fingerprints which can be identified also in astrophysical and cometary materials. The laboratory methodologies used so far are also critically discussed in order to point out capabilities and present limitations, in the view of possible application to returned comet samples. Suggestions are given to develop new techniques which should overcome some of the problems faced in the manipulation and analysis of micron solid samples.

29293 (N–90-16607, pp. 16-17) **Analysis of organic compounds in returned comet nucleus samples.** Cronin, J.R. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Techniques for analysis of organic compounds in returned comet nucleus samples are described. Interstellar, chondritic and transitional organic components are discussed. Appropriate sampling procedures will be essential to the success of these analyses. It will be necessary to return samples that represent all the various regimes found in the nucleus, e.g., a complete core, volatile components (deep interior), and crustal components (surface minerals, rocks, processed organics such as macromolecular carbon and polymers). Furthermore, sampling, storage, return, and distribution of samples must be done under conditions that preclude contamination of the samples by terrestrial matter.

29294 (N–90-16607, pp. 18-19) **Non-equilibrium chemistry in the solar nebula and early solar system: Implications for the chemistry of comets.** Fegley, B. Jr. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Theoretical models of solar nebula and early solar system chemistry which take into account the interplay between chemical, physical, and dynamical processes have great utility for deciphering the origin and evolution of the abundant chemically reactive volatiles (H, O, C, N, S) observed in comets. In particular, such models are essential for attempting to distinguish between presolar and solar nebula products and for quantifying the nature and duration of nebular and early solar system processing to which the volatile constituents of comets have been subjected. The diverse processes and energy sources responsible for chemical processing in the solar nebula and early solar system are discussed. The processes considered include homogeneous and heterogeneous thermochemical and photochemical reactions, and disequilibration resulting from fluid transport, condensation, and cooling whenever they occur on timescales shorter than those for chemical reactions.

29295 (N–90-16607, pp. 22-23) **From interstellar dust to comets.** Greenberg, J.M. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The bulk and microstructure of comet nuclei are derived from the morphological structure and chemical composition of submicron sized interstellar dust grains which have undergone cold aggregation in the pre-solar nebula. The evolutionary picture of dust which is emerging is a cyclic one in which the particles, before being destroyed or going into solar system bodies, find themselves during their 5 billion year lifetime alternately in diffuse clouds and in molecular clouds. A small silicate core captured within a molecular cloud accretes various ices and gradually builds up an inner mantle of organic refractory material which has been produced by photoprocessing of the volatile ices. Clumps of grains form, and then clumps of clumps, and so on, until finally we reach the size of the comet nucleus.

29296 (N–90-16607, pp. 24-25) **Modifications of comet materials by the sublimation process: Results from simulation experiments.** Gruen, E. (Muenster Univ. (Germany, F.R.)); Bar-Nun, A.; Lammerzahl, P.; Klinger, J.; Kochan, H.; Keller, H.U.; Neukum, G.; Roessler, K.; Stoeffler, D.; Spohn, T. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

An active comet like comet Halley loses by sublimation a surface layer of the order of 1 m thickness per perihelion passage. In situ measurements show that water ice is the main constituent which contributes to the gas emission although even more volatile species (CO, NH_3, CH_4, CO_2 etc.) have been identified. Dust particles which were embedded in the ices are carried by the sublimating gases. Measurements of the chemical composition of cometary grains indicate that they are composed of silicates of approximate chondritic composition and refractory carbonaceous material. Comet simulation experiments show that significant modifications of cometary materials occur due to sublimation process in near surface layers which have to be taken into account in order to derive the original state of the material.

29297 (N–90-16607, pp. 26-27) **Comments on comet shapes and aggregation processes.** Hartmann, W.K. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

An important question for a comet mission is whether comet nuclei preserve information clarifying aggregation processes of planetary matter. New observational evidence shows that Trojan asteroids, as a group, display a higher fraction of highly-elongated objects than the belt. More recently evidence has accumulated that comet nuclei, as a group, also display highly-elongated shapes at macro-scale. This evidence comes from the several comets whose

nuclear lightcurves or shapes have been well studied. Trojans and comet nuclei share other properties. Both groups have extremely low albedos and reddish-to neutral-black colors typical of asteroids of spectral class D, P, and C. Both groups may have had relatively low collision frequencies. An important problem to resolve with spacecraft imaging is whether these elongated shapes are primordial, or due to evolution of the objects. Two hypotheses that might be tested by a combination of global-scale and close-up imaging from various directions are: (1) The irregular shapes are primordial and related to the fact that these bodies have had lower collision frequencies than belt asteroids; or (2) The irregular shapes may be due to volatile loss.

29298 (N–90-16607, pp. 28-29) **Cosmogenic nuclides in cometary materials: Implications for rate of mass loss and exposure history.** Herzog, G.F. (Los Alamos National Lab., NM (USA)); Englert, P.A.J.; Reedy, R.C. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

As planned, the Rosetta mission will return to earth with a 10-kg core and a 1-kg surface sample from a comet. The selection of a comet with low current activity will maximize the chance of obtaining material altered as little as possible. Current temperature and level of activity, however, may not reliably indicate previous values. Fortunately, from measurements of the cosmogenic nuclide contents of cometary material, one may estimate a rate of mass loss in the past and perhaps learn something about the exposure history of the comet. Perhaps the simplest way to estimate the rate of mass loss is to compare the total inventories of several long-lived cosmogenic radionuclides with the values expected on the basis of model calculations. Although model calculations have become steadily more reliable, application to bodies with the composition of comets will require some extension beyond the normal range of use. In particular, the influence of light elements on the secondary particle cascade will need study, in part through laboratory irradiations of volatile-rich materials. In the analysis of cometary data, it would be valuable to test calculations against measurements of short-lived isotopes.

29299 (N–90-16607, pp. 30) **Morphology and compositional differentiation of the surface of comets.** Huebner, W.F.; Boice, D.C. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The spacecraft missions to Comet Halley gave us the first detailed view of a comet nucleus. What was suspected before, that the nucleus surface was heterogeneous, was confirmed. The Halley Multicolor Camera aboard Giotto recorded jet-like dust features emanating from active regions covering approximately 15 percent of the surface that were responsible for emitting most of the dust and gas. An intensity gradient across the nucleus originating at the active areas and falling off to the darker, inactive region on the night side is caused by small particles that are more easily entrained by surface winds than larger particles that tend to remain in the jets. Data from the PIA (Giotto) and PUMA (Vega 1,2) instruments indicate that the smallest dust particles are enriched with organics (CHON particles). Some of this fine dust gravitationally settles creating a thin surface layer rich in organics. Particularly strong dust jets may cause wind-blown surface structures over inactive areas, such as, leeward dust accumulation behind hills. At close heliocentric distances the fine dust may be sintered on the surface.

29300 (N–90-16607, pp. 32) **Radiation modification of cometary materials: Laboratory simulations.** Johnson, R.E. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Cosmic rays and solar photons can modify precometary materials, comet surfaces, and ejected cometary materials. This can be of importance for describing the primordial crust of a comet, the composition of the ejected dust, and the degradation of the dust in the solar environment. The laboratory results of interest to radiation modification of materials, the effects of radiation on cometary materials and the relevance of these materials for comet surface analysis, are described.

29301 (N–90-16607, pp. 33-34) **Sulfur compounds in comets.** Kim, S.; Ahearn, M. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Cometary atmospheres exhibit abundant sulfur and sulfur compounds, which are absent in planetary atmospheres. Sulfur compounds were also detected in interstellar media, including SO, SO_2, CS, etc., but excluding S_2 which was identified only in IRAS-Araki-Alcock 1983d. Fluorescence calculations are used to analyze the B-X system of S_2 which appeared in IUE and ground-based spectra of IRAS-Araki-Alcock 1983d. Single- and multiple-cycle fluorescence calculations indicate that fluorescent equilibrium accounts for the observed spectra despite the fact that the S_2 lifetime against solar ultraviolet radiation is relatively short. This analysis confirms unambiguously that emission peaks in the 3000 to 4000 A spectral range of the ground-based data are due to the B-X bands of S_2. New evidence is presented of at least one S_2 outburst before it was detected by A'Hearn, Feldman, and Schleicher. The time variation of S_2 outgassing rates and discussion on the correlation between solar wind flux and the S_2 outbursts will be presented.

29302 (N–90-16607, pp. 35) **Organic chemistry of cometary dust as derived from PUMA 1 data.** Kissel, J. (Ingenieurbuero Krueger, Darmstadt (Germany, F.R.)); Krueger, F.R. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Onboard the Halley Fly-By spacecrafts Vega 1, Vega 2, and Giotto were the dust impact mass spectrometers PUMA 1, PUMA 2, and PIA respectively. PUMA 1 was the most sensitive instrument among them. From its data the occurrence of masslines greater than 60 Daltons could be shown to be statistically significant. An analysis of these masslines lead to a scenario, which could explain the masslines as fragment ions from larger molecules which characterize the chemical nature of cometary organic matter as: (1) highly unsaturated hydrocarbons; (2) some of them containing oxygen; (3) less containing nitrogen; and (4) a few containing oxygen and nitrogen as heteroatoms. From the properties of the spectrometer, also some physical parameters of the dust particles could be inferred, such as their density and structure.

29303 (N–90-16607, pp. 38-39) **Spectrophotometric observations of comet P/Giacobini-Zinner.** Konno, I. (Arizona State Univ., Tempe (USA)); Wyckoff, S.; Wehinger, P.A. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Spectroscopic observations of the Giacobini-Zinner comet were performed on March 20, June 20 and 21, September 11, and October 19, 1985. The September observations were performed at perihelion, exactly at the time of the International Cometary Explorer (ICE) encounter with the comet. The March and June observations were obtained with an intensified image dissector scanner (IIDS) on the 2.1-meter Kitt Peak telescope and the September and the October observations were obtained with a charge-coupled device (CCD) on the 4-meter Kitt Peak telescope. The nucleus spectra from these observations are presented.

29304 (N–90-16607, pp. 40) **Composition of dust from Comet P/Halley: The mineral fraction.** Langevin, Y. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The composition of dust from Comet Halley was investigated in situ during the Vega 1, Vega 2, and Giotto encounters by the PIA/PUMA impact mass spectrometers. More than 5000 meaningful spectra of individual dust particles were obtained, most in a compressed mode. The interpretation of these spectra in terms of elemental and mineralogical composition will be discussed. Accounting for these difficulties, the following conclusions can be derived for the mineral fraction of dust particles: (1) the observed compositions are compatible with the full range of observed meteoritic minerals (in particular mafic silicates, plagioclases, sulfides, oxides); and (2) within each mineralogical class, the spread in composition appears much wider and more uniform than in meteorites. The low overall density and very large excess of light elements will be discussed. These first direct results on cometary dust considerably strengthen the case for a comet sample return mission.

29305 (N–90-16607, pp. 43-44) **Prompt Gamma Activation Analysis (PGAA): Technique of choice for nondestructive bulk analysis of returned comet samples.** Lindstrom, D.J. (National Inst. of Standards and Technology, Gaithersburg, MD (USA)); Lindstrom, R.M. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Prompt gamma activation analysis (PGAA) is a well-developed analytical technique. The technique involves irradiation of samples in an external neutron beam from a nuclear reactor, with simultaneous counting of gamma rays produced in the sample by neutron capture. Capture of neutrons leads to excited nuclei which decay immediately with the emission of energetic gamma rays to the ground state. PGAA has several advantages over other techniques for the analysis of cometary materials: (1) It is nondestructive; (2) It can be used to determine abundances of a wide variety of elements, including most major and minor elements (Na, Mg, Al, Si, P, K, Ca, Ti, Cr, Mn, Fe, Co, Ni), volatiles (H, C, N, F, Cl, S), and some trace elements (those with high neutron capture cross sections, including B, Cd, Nd, Sm, and Gd); and (3) It is a true bulk analysis technique. Recent developments should improve the technique's sensitivity and accuracy considerably.

29306 (N–90-16607, pp. 45-46) **Solar nebula condensates and the composition of comets.** Lunine, J.I. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Interpretation of the volatile abundances in Halley's comet in terms of models for chemical and physical processes in the solar nebula are discussed. Key ratios of the oxidized and reduced species of nitrogen and carbon are identified which tell something of the chemical history of the environment in which cometary grains accreted to form the nucleus. Isotopic abundances are also applied to this problem. It will be shown that the abundances of methane and carbon monoxide are consistent both with models of solar nebula chemistry and chemical processing on grains in star-forming regions. Ultimately, limitations of the current data set on molecular abundances in comets and star-forming regions prevent a definitive choice between the two. Processes important to the composition of outer solar system bodies are: (1) gas phase chemistry in the solar nebula; (2) imperfect mixing in the solar nebula; (3) condensation; (4) clathration; (5) adsorption; and (6) processing of interstellar material.

29307 (N–90-16607, pp. 47) **Candidate sample acquisition systems for the Rosetta.** Magnani, P.G. (Tecnomare S.p.A. (Italy)); Gerli, C.; Colombina, G.; Vielmo, P. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The Comet Nucleus Sample Return (CNSR) mission, one of the four cornerstones of the ESA scientific program, is one of the most complex space ventures within the next century, both from technological and deep space exploration point of view. In the Rosetta scenario the sample acquisition phase represents the most critical point for the global mission's success. The proposed paper illustrates the main results obtained in the context of the CNSR-SAS ongoing activity. The main areas covered are related to: (1) sample properties characterization (comet soil model, physical/chemical properties, reference material for testing); (2) concepts identification for coring, shovelling, harpooning and anchoring; (3) preferred concept (trade off among concepts, identification of the preferred configuration); and (4) proposed development activity for gaining the necessary confidence before finalizing the CNSR mission. Particular emphasis will be given to the robotic and flexibility aspects of the identified sample acquisition systems (SAS) configuration, intended as a means for the overall system performance enhancement.

29308 (N–90-16607, pp. 48-49) **Interstellar and cometary dust.** Mathis, J.S. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Aspects of interstellar dust which are known from direct observation will be discussed. Some specific difficulties that various theories have in explaining the observations will be presented. Several theoretical interpretations which have been advanced will be discussed, highlighting first their similarities and then their differences. Also discussed will be the author's ideas about the conditions of interstellar dust throughout its life cycle, from origin to incorporation in pre-cometary ices. Dust is primarily observed by its effects on the spectra of background stars, so observations at optical and ultraviolet (UV) wavelengths are confined to the diffuse interstellar medium (ISM) or to the outer regions of dense clouds. Within this somewhat limited range of environments there are very few lines of sight which show any evidence for icy mantles, but there are major variations in the wavelength dependence of the extinction. In the infrared region of the spectrum, it is possible to observe a few stellar sources deeply embedded within molecular clouds.

29309 (N–90-16607, pp. 50-51) **The in-situ cometary particulate size distribution measured for one comet: P/Halley.** McDonnell, J.A.M.; Pankiewicz, G.S. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The close approach of Giotto to comet Halley during its 1986 apparition offered an opportunity to study the particulate mass distribution to masses of up to one gram. Data acquired by the front end channels of the highly sensitive mass spectrometer PIA and the dust shield detector system, DIDSY, provide definition to the detected distribution as close as 1000 km to the nucleus. Dynamic motion of the particulates after emission leads to a spatial differentiation affecting the size distribution in several forms: (1) ejecta velocity dispersion; (2) radiation pressure; (3) varying heliocentric distance; and (4) anisotropic nucleus emission. Transformation of the in-situ distribution from PIA and DIDSY weighted heavily by the near-nucleus fluxes leads to a presumed nucleus distribution. The data lead to a puzzling distribution at large masses, not readily explained in an otherwise monotonous power law distribution. Although temporal changes in nucleus activity could and do modify the in-situ size distribution, such an explanation is not wholly possible, because the same form is observed at differing locations in the coma where the time of flight from the nucleus greatly varies. Thus

neither a general change in comet activity nor spatial variations lead to a satisfactory explanation.

29310 (N–90-16607, pp. 54-55) **The comet rendezvous asteroid flyby mission.** Morrison, D. (Jet Propulsion Lab., Pasadena, CA (USA)); Neugebauer, M.; Weissman, P.R. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The Comet Rendezvous Asteroid Flyby (CRAF) mission is designed to answer the many questions raised by the Halley missions by exploring a cometary nucleus in detail, following it around its orbit and studying its changing activity as it moves closer to and then away from the Sun. In addition, on its way to rendezvous with the comet, CRAF will fly by a large, primitive class main belt asteroid and will return valuable data for comparison with the comet results. The selected asteroid is 449 Hamburga with a diameter of 88 km and a surface composition of carbonaceous chondrite meteorites. The expected flyby date is January, 1998. The CRAF spacecraft will continue to make measurements in orbit around the cometary nucleus as they both move closer to the Sun, until the dust and gas hazard becomes unsafe. At that point the spacecraft will move in and out between 50 and 2,500 kilometers to study the inner coma and the cometary ionosphere, and to collect dust and gas samples for onboard analysis. Following perihelion, the spacecraft will make a 50,000 km excursion down the comet's tail, further investigating the solar wind interaction with the cometary atmosphere. The spacecraft will return to the vicinity of the nucleus about four months after perihelion to observe the changes that have taken place. If the spacecraft remains healthy and adequate fuel is still onboard, an extended mission to follow the comet nucleus out to aphelion is anticipated.

29311 (N–90-16607, pp. 56-57) **Measurements of long-lived cosmogenic nuclides in returned comet nucleus samples.** Nishiizumi, K.; Kohl, C.P.; Arnold, J.R. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Measurements of long lived cosmic ray produced radionuclides have given much information on the histories and rates of surface evolution for meteorites, the Moon and the Earth. These nuclides can be equally useful in studying cometary histories and post nebular processing of cometary surfaces. The concentration of these nuclides depends on the orbit of the comet (cosmic ray intensity changes with distance from the sun), the depth of the sampling site in the comet surface, and the rate of continuous evolution of the surface (erosion rate of surface materials). If the orbital parameters and the sampling depth are known, production rates of cosmogenic nuclides can be fairly accurately calculated by theoretical models normalized to measurement on lunar surface materials and meteoritic samples. Due to the continuous evaporation of surface materials, it is expected that the long lived radioactivities will be undersaturated. Accurate measurements of the degree of undersaturation in nuclides of different half-lives allows for the determination of the rate of surface material loss over the last few million years.

29312 (N–90-16607, pp. 58) **Metamorphism of cosmic dust: Processing from circumstellar outflows to the cometary regolith.** Nuth, J.A. III. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Metamorphism of refractory particles continues in the interstellar medium (ISM) where the driving forces are sputtering by cosmic ray particles, annealing by high energy photons, and grain destruction in supernova generated shocks. Studies of the depletion of the elements from the gas phase of the interstellar medium tell us that if grain destruction occurs with high efficiency in the ISM, then there must be some mechanism by which grains can be formed in the ISM. Most grains in a cloud which collapses to form a star will be destroyed; many of the surviving grains will be severely processed. Grains in the outermost regions of the nebula may survive relatively unchanged by thermal processing or hydration. It is these grains which one hopes to find in comets. However, only those grains encased in ice at low temperature can be considered pristine since a considerable degree of hydrous alteration might occur in a cometary regolith if the comet enters the inner solar system. The physical, chemical and isotopic properties of a refractory grain at each stage of its life cycle will be discussed.

29313 (N–90-16607, pp. 60-61) **What if chondritic porous interplanetary dust particles are not the real McCoy.** Rietmeijer, F.J.M. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

To select a target comet for a Comet Nucleus Sample Return Mission (CNSRM) it is necessary to have an experimental data base to evaluate the extent of diversity and similarity of comets. For example, the physical properties (e.g., low density) of chondritic porous (CP) interplanetary dust particles (IDPs) are believed to resemble these properties of cometary dust although it is yet to be demonstrated that the porous structure of CP IDPs is inherent to presolar dust particles stored in comet nuclei. Porous structures of IDPs could conceivably form during sublimation at the surface of active comet nuclei. Porous structures are also obtained during annealing of amorphous Mg-SiO smokes which initially forms porous aggregates of olivine + platey tridymite and which, upon continued annealing, react to fluffy enstatite aggregates. It is therefore uncertain that CP IDPs are entirely composed of unmetamorphosed presolar dust. Conceivably, new minerals and textures may form in situ in nuclei of active comets as a function of their individual thermal history. Unmetamorphosed comet dust is probably structurally amorphous. Thermal annealing of this dust can produce ultra fine-grained minerals and this ultrafine grain size of CP IDPs should be considered in assessments of aqueous alterations that could affect presolar dust in comet nuclei between 200 and 400 K. Devitrification and hydration may occur in situ in ice-dust mixtures and the mantle of active comet nuclei. Devitrification, or uncontrolled crystallization, of amorphous precursor dust can produce a range of chemical compositions of ultrafine-grained minerals and (non-equilibrium) mineral assemblages and textures in dust contained in comet nuclei as a function of period and trajectory of orbit and number of perihelion passages (not considering internal heating).

29314 (N–90-16607, pp. 62-63) **Handling and analysis of ices in cryostats and glove boxes in view of cometary samples.** Roessler, K. (Ruhr Univ., Bochum (Germany, F.R.)); Eich, G.; Heyl, M.; Kochan, H.; Oehler, A.; Patnaik, A.; Schlosser, W.; Schulz, R. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Comet nucleus sample return mission and other return missions from planets and satellites need equipment for handling and analysis of icy samples at low temperatures under vacuum or protective gas. Two methods are reported which were developed for analysis of small icy samples and which are modified for larger samples in cometary matter simulation experiments (KOSI). A conventional optical cryostat system was modified to allow for transport of samples at 5 K, ion beam irradiation, and measurement in an off-line optical spectrophotometer. The new system consists of a removable window plug containing nozzles for condensation of water and volatiles onto a cold finger. This plug can be removed in a vacuum system, changed against another plug (e.g., with other windows (IR, VIS, VUV) or other nozzles). While open, the samples can be treated under vacuum with cooling by manipulators (cut, removal, sample taking, irradiation with light, photons, or ions). After bringing the plug back, the samples can be moved to another site of analysis. For handling the 30 cm diameter mineral-ice samples

from the KOSI experiments an 80x80x80 cm glove box made out of plexiglass was used. The samples were kept in a liquid nitrogen bath, which was filled from the outside. A stream a dry N_2 and evaporating gas from the bath purified the glove box from impurity gases and, in particular, H_2O, which otherwise would condense onto the samples.

29315 (N–90-16607, pp. 64-65) **Trajectory-capture cell instrumentation for measurement of dust particle mass, velocity and trajectory, and particle capture.** Simpson, J.A.; Tuzzolino, A.J. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The development of the polyvinylidene fluoride (PVDF) dust detector for space missions–such as the Halley Comet Missions where the impact velocity was very high as well as for missions where the impact velocity is low was extended to include: (1) the capability for impact position determination - i.e., x,y coordinate of impact; and (2) the capability for particle velocity determination using two thin PVDF sensors spaced a given distance apart - i.e., by time-of-flight. These developments have led to space flight instrumentation for recovery-type missions, which will measure the masses (sizes), fluxes and trajectories of incoming dust particles and will capture the dust material in a form suitable for later Earth-based laboratory measurements. These laboratory measurements would determine the elemental, isotopic and mineralogical properties of the captured dust and relate these to possible sources of the dust material (i.e., comets, asteroids), using the trajectory information. The instrumentation described here has the unique advantages of providing both orbital characteristics and physical and chemical properties–as well as possible origin–of incoming dust.

29316 (N–90-16607, pp. 66-67) **Thermal histories of the samples of two KOSI comet nucleus simulation experiments.** Spohn, T. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.)); Benkhoff, J.; Klinger, J.; Gruen, E.; Kochan, H. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Temperatures recorded during two KOSI comet nucleus simulation experiments strongly suggest that heat transport by vapor flow into the interior of the sample is very important. Two comet nucleus simulation experiments have been done by the KOSI team in a big space simulator. The thermal evolution of the sample during insolation and the results of simplified thermal evolution calculations are discussed. The observed thermal histories cannot be explained by a simple model with heat transferred by heat conduction at a constant conductivity, so a coupled heat and mass transfer problem was considered. The porous ice matrix was assumed to have a constant thermal conductivity and to be in thermal equilibrium with vapor in the pores, the internal pressure being the vapor pressure. The vapor was modelled as an ideal gas because, at the temperatures relevant to the problem, the mean free path length of the vapor molecules is large in comparison with the pore dimensions. The heat capacity at constant volume per unit mass of the two phase mixture was also assumed constant. The vapor was allowed to flow and transfer heat in response to an internal pressure gradient.

29317 (N–90-16607, pp. 68-69) **Analysis of particulates of comet nucleus samples: Possible use of olivine as indicator phase.** Steele, I.M. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The electron microprobe is a proven instrument for particulate analysis and modifications are possible for in situ analysis of particulates in ice at temperatures near that of liquid nitrogen. Present sample requirements allow for polished samples with 0.25 x 0.25 dimensions to be maintained in the sample chamber of a modern electron probe (CAMECA SX-50) at a temperature of -150 C; larger samples are possible but at higher temperatures as determined by thermal conductivity. The major problem is transport and insertion of samples into the instrument through vacuum interlocks. The manufacturer of the above microprobe has designed an exchange mechanism to allow storage and transport of samples previously prepared for their sample holder which attaches to their instrument allowing extraction and insertion of samples while maintaining -150 C temperature. An important test will be the capability of preparing polished surfaces of an ice-particulate sample without loss of particles and at low temperatures. While thin sections of water ice are routine, these are not examined for particulate material and are prepared at temperatures easily obtained in room-size volumes. Anticipated problems include rounding of small grains in the relatively soft ice matrix and the technical problem of dry polishing.

29318 (N–90-16607, pp. 70) **The nature of cometary materials.** Stephens, J. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Because cometary surfaces are likely to be far colder and of a different composition than planetary surfaces, there are some new considerations that must be examined in regards to placing instrumented packages or sample return devices on their surfaces. The qualitative analysis of the problem of attaching hardware to a comet and not being ejected back into space can be divided into two parts. The first problem is to pierce the mantle and obtain access to the icy core. Drilling through the mantle requires that the drilling forces be reacted. Reacting such forces probably requires attachment to the icy core below. Therefore, some kinetic impact piercing device is likely to be required as the first act of attachment. The second problem for a piercing device to overcome is the force produced by the impact kinetic energy that tries to eject the piercing device back into space. The mantle and icy core can absorb some of the impact kinetic energy in the form of fracture formation and friction energy. The energy that is not absorbed in these two ways is stored by the core as elastic deformation of the mantle and icy core. It is concluded that because the cometary materials are almost certainly brittle and the icy core is likely to be self lubricating, the elastic rebound and gas pressure expulsion forces must be counteracted by forces greater than those that may be provided by a piercing device or its capture devices (barbs).

29319 (N–90-16607, pp. 71-72) **Methods for the mineralogical and textural analysis of comet nucleus samples.** Stoeffler, D.; Dueren, H.; Knoelker, J. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The objectives and instrumental requirements of a petrographic analysis of porous comet nucleus material are reviewed. Assumptions about its composition and texture, and the available techniques for the microscopic analysis of comet analogue material are investigated. New techniques required for the petrographic investigation of natural and artificial comet nucleus samples are also considered.

29320 (N–90-16607, pp. 73-74) **Non-destructive trace element microanalysis of as-received cometary nucleus samples using synchrotron x ray fluorescence.** Sutton, S.R. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The Synchrotron X ray Fluorescence (SXRF) microprobe at the National Synchrotron Light Source (NSLS), Brookhaven National Laboratory, will be an excellent instrument for non-destructive trace

element analyses of cometary nucleus samples. Trace element analyses of as-received cometary nucleus material will also be possible with this technique. Bulk analysis of relatively volatile elements will be important in establishing comet formation conditions. However, as demonstrated for meteorites, microanalyses of individual phases in their petrographic context are crucial in defining the histories of particular components in unequilibrated specimens. Perhaps most informative in comparing cometary material with meteorites will be the halogens and trace metals. In-situ, high spatial resolution microanalyses will be essential in establishing host phases for these elements and identifying terrestrial (collection/processing) overprints. The present SXRF microprobe is a simple, yet powerful, instrument in which specimens are excited with filtered, continuum synchrotron radiation from a bending magnet on a 2.5 GeV electron storage ring. A refrigerated cell will be constructed to permit analyses at low temperatures. The cell will consist essentially of an air tight housing with a cold stage. Kapton windows will be used to allow the incident synchrotron beam to enter the cell and fluorescent x rays to exit it. The cell will be either under vacuum or continuous purge by ultrapure helium during analyses. Several other improvements of the NSLS microprobe will be made prior to the cometary nucleus sample return mission that will greatly enhance the sensitivity of the technique.

29321 (N–90-16607, pp. 75-76) **Mechanical and SEM analysis of artificial comet nucleus samples.** Thiel, K. (Kernforschungsanlage, Juelich (Germany, F.R.)); Kochan, H.; Roessler, K.; Gruen, E.; Schwehm, G.; Hellmann, H.; Hsiung, P.; Koelzer, G. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Since 1987 experiments dealing with comet nucleus phenomena have been carried out in the DFVLR space simulation chambers. The main objective of these experiments is a better understanding of thermal behavior, surface phenomena and especially the gas dust interaction. As a function of different sample compositions and exposure to solar irradiation (xenon-bulbs) crusts of different hardness and thickness were measured. The measuring device consists of a motor driven pressure foot (5 mm diameter), which is pressed into the sample. The applied compressive force is electronically monitored. The microstructure of the crust and dust residuals is investigated by scanning electron microscopy (SEM) techniques. Stress-depth profiles of an unirradiated and an irradiated model comet are given.

29322 (N–90-16607, pp. 77-78) **Electron Spin Resonance (ESR) studies of returned comet nucleus samples.** Tsay, Fundow; Kim, S.S.; Liang, R.H. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The most important objective of the Comet Nucleus Sample Return Mission is to return samples which could reflect formation conditions and evolutionary processes in the early solar nebula. It is expected that the returned samples will consist of fine-grained silicate materials mixed with ices composed of simple molecules such as H_2O, NH_3, CH_4 as well as organics and/or more complex compounds. Because of the exposure to ionizing radiation from cosmic-ray, gamma-ray, and solar wind protons at low temperature, free radicals are expected to be formed and trapped in the solid ice matrices. The kind of trapped radical species together with their concentration and thermal stability can be used as a dosimeter as well as a geothermometer to determine thermal and radiation histories as well as outgassing and other possible alternation effects since the nucleus material was formed. Since free radicals that are known to contain unpaired electrons are all paramagnetic in nature, they can be readily detected and characterized in their native form by the Electron Spin Resonance (ESR) method. In fact, ESR has been shown to be a non-destructive, highly sensitive tool for the detection and characterization of paramagnetic, ferromagnetic, and radiation damage centers in terrestrial and extraterrestrial geological samples. The potential use of ESR as an effective method in the study of returned comet nucleus samples, in particular, in the analysis of fine-grained solid state icy samples is discussed.

29323 (N–90-16607, pp. 79-80) **Ion bombardment experiments suggesting an origin for organic particles in pre-cometary and cometary ices.** Wdowiak, T.J.; Robinson, E.L.; Flickinger, G.C.; Boyd, D.A. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

During the Giotto and Vega encounters with Comet Halley both organic particles called CHON and energetic ions were detected. The acceleration of ions to hundreds of keV in the vicinity of the bow shock and near the nucleus may be a demonstration of a situation occurring in the early solar system (perhaps during the T Tauri stage) that led to the formation of organic particles only now released. Utilizing a Van de Graaff accelerator and a target chamber having cryogenic and mass spectrometer capabilities, frozen gases were bombarded at 10 K with 175 keV protons with the result that fluffy solid material remains after sublimation of the ice. Initial experiments were carried out with a gas mixture in parts of 170 carbon monoxide, 170 argon, 25 water, 20 nitrogen, and 15 methane formulated to reflect an interstellar composition in experiments involving the freezing out of the products of a plasma. The plasma experiments resulted in a varnish-like film residue that exhibited luminescence when excited with ultraviolet radiation, while the ion bombardment created particulate material that was not luminescent.

29324 (N–90-16607, pp. 81-82) **Physical processing of cometary nuclei.** Weissman, P.R. (Colorado Univ., Boulder (USA)); Stern, S.A. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Cometary nuclei were formed far from the Sun in the colder regions of the solar nebula, and have been stored in distant orbits in the Oort cloud over most of the history of the solar system. It had been thought that this benign environment would preserve comets in close to their original pristine state. However, recent studies have identified a number of physical processes that have likely acted to modify cometary nuclei in a variety of significant ways. It is important to consider all of these possible processes, both in deciding on a site on the nucleus for collection of cometary samples, and in interpreting the results of analyses of returned cometary samples. Although it can no longer be said that comets are pristine samples of original solar nebula material, they are still the best obtainable samples of that unique period in the formation of the planetary system.

29325 (N–90-16607, pp. 84-85) **Refractory solids in chondrites and comets: How similar.** Wood, J.A. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

The grains of ice, dust, and organic material that came together to form the solar system have been preserved to differing degrees in the most primitive solar system bodies, asteroids and comets. The study of samples of asteroids (in the form of chondritic meteorites) reveals that the dust component was extensively altered by high-temperature events and processes in the early solar system, before it was aggregated into chondritic planetesimals. The nature of these high-temperature events and processes is not known, but the evidence of their operation is pervasive and unequivocal. Are the refractory particles in comets likely to be similar to these chondrite components. Probably not (except for the presolar carbonaceous grains in chondrites), because the chondritic components are products of severe thermal processing, and all

imaginable energy sources that could have provided the heat tend to diminish with distance from the sun. Every indication is that comets formed at much greater radial distances than asteroids, so the particles they incorporated would have experienced less heating. The possibilities cannot be completely ruled out that comets, too, formed inside the present orbit of Jupiter, or that thermally-processed grains were able to diffuse great radial distances before being incorporated in accreting objects, but it is far more likely that most of the refractory grains in comets have been spared the extreme thermal processing that shaped the character of chondritic components.

29326 (N–90-16607, pp. 86-87) **Isotopic microanalysis of returned comet nucleus samples.** Zinner, E. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

If isotopic measurements of interplanetary dust particles (IDPs) and primitive meteorites can serve as a guide to the isotopic analysis of returned comet nucleus material, an essential requirement will be the capability for microanalysis. The reason is that in both types of extraterrestrial samples large isotopic heterogeneities on a small spatial scale have become apparent once it was possible to measure isotopes in small samples. In the discovery of large isotopic anomalies the ion microprobe has played a significant role because of its high spatial resolution for isotopic ratio measurements. The largest isotopic anomalies in C, N, O, Mg, Si, Ca and Ti found to date were measured by ion microprobe mass spectrometry. The most striking examples are D/H measurements in IDPs and isotopic measurements of C, N and Si in SiC from the CM chondrites Murray and Murchison.

29327 (N–90-16607, pp. 88-89) **The measurement of trace elements in interplanetary dust and cometary particles by ultra-high sensitivity INAA.** Zolensky, M.E. (National Inst. of Standards and Technology, Gaithersburg, MD (USA)); Lindstrom, D.J.; Lindstrom, R.M.; Lindstrom, M.M. Lunar and Planetary Inst., Houston, TX (USA). 1989. (NASA-CR–184821;NAS–1.26:184821;LPI-CONTRIB–691;CONF-890195–: Workshop on the analysis of returned comet nucleus samples, Milpitas, CA (USA), 16-18 Jan 1989). In *Workshop on Analysis of Returned Comet Nucleus Samples.* Available from NTIS, PC A05/MF A01.

Today the major elemental composition of interplanetary dust particles (IDPs) is routinely determined in many laboratories. These and mineralogical studies have revealed the presence of at least two major types of IDPs, chondritic and refractory. Preliminary results of a successful attempt to determine abundances of a large suite of trace elements from both chondritic and refractory IDPs are reported. The analytical procedure can be used in the grain-by-grain analysis of returned cometary samples. Chondritic and refractory IDPs are characterized by standard scanning electron microscopy and energy dispersive x ray spectroscopy (SEM-EDX) techniques. With this system, detection limits for many elements are well below picogram levels, and some approach femtogram levels. This technique is non-destructive, although some sample handling is required, so particles can be analyzed by other techniques after instrument neutron activation analysis (INAA) is completed. Data is presently being reduced from the analyses of 7 IDPs. These are U2015E10, U2015F1, W7029-A2, W7029-A3, W7013A8, LACI (all chondritic) and 705 (refractory). So far, 17 different major and trace elements were detected and measured in these particles, including rare earths and some very volatile elements (Br and Zn).

29328 (N–90-16676) **Determination of solar flare accelerated ion angular distributions from SMM gamma ray and neutron measurements and determination of the He-3/H ratio in the solar photosphere from SMM gamma ray measurements. Final technical report, 1 July 1987-31 August 1989.** Lingenfelter, R.E. California Univ., La Jolla, CA (USA). Aug 1989. 7p. (NASA-CR–186038;NAS–1.26:186038). Available from NTIS, PC A02/MF A01.

Comparisons of Solar Maximum Mission (SMM) observations of gamma-ray line and neutron emission with theoretical calculation of their expected production by flare accelerated ion interactions in the solar atmosphere have led to significant advances in the understanding of solar flare particle acceleration and interaction, as well as the flare process itself. These comparisons have enabled the determination of, not only the total number and energy spectrum of accelerated ions trapped at the sun, but also the ion angular distribution as they interact in the solar atmosphere. The Monte Carlo program was modified to include in the calculations of ion trajectories the effects of both mirroring in converging magnetic fields and of pitch angle scattering. Comparing the results of these calculations with the SMM observations, not only the angular distribution of the interacting ions can be determined, but also the initial angular distribution of the ions at acceleration. The reliable determination of the solar photospheric He-3 abundance is of great importance for understanding nucleosynthesis in the early universe and its implications for cosmology, as well as for the study of the evolution of the sun. It is also essential for the determinations of the spectrum and total number of flare accelerated ions from the SMM/GRS gamma-ray line measurements. Systematic Monte Carlo calculations of the time dependence were made as a function of the He-3 abundance and other variables. A new series of calculations were compared for the time-dependent flux of 2.223 MeV neutron capture line emission and the ratio of the time-integrated flux in the 2.223 MeV line to that in the 4.1 to 6.4 MeV nuclear deexcitation band.

29329 (PB–90-148677/XAB) **Solar-Geophysical Data Number 542, October 1989. Part 2 (comprehensive reports). Data for April 1989 and miscellaneous.** Coffey, H.E. National Geophysical Data Center, Boulder, CO (USA). Oct 1989. 102p. (SGD–542-PT-2). Available from NTIS, PC A06/MF A01.

See also Part 1, PB–90-148669.

Contents: detailed index for 1989; data for April 1989 – solar flares, solar radio bursts at fixed frequencies, interplanetary solar particles and plasma, solar x-ray radiation from GOES satellite, mass ejections from the sun, active prominences and filaments; miscellaneous data – Meudon Carte synoptique carrington rotations 1811-1812, solar ultraviolet radiation Nimbus 7 November 1978-October 1984.

29330 (PB–90-858762/XAB) **Planetary volcanology. November 1972-January 1990 (A Bibliography from the International Aerospace Abstracts data base). Report for November 1972-January 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 88p. Available from NTISPC N01/MF N01.

U.S. sales only.

This bibliography contains citations concerning the causes and effects of volcanism on neighboring planets and their satellites. From Mars' relatively quiet nature to the violent activity on Jupiter's moon IO, these citations emphasize the current theories being developed on extra-terrestrial volcanism, especially where it applies to an understanding of Earth's own evolution, and to that of the solar system. (Contains 188 citations fully indexed and including a title list.)

29331 (PB–90-859844/XAB) **Sunspots: Solar-terrestrial interactions. September 1972-January 1990 (A Bibliography from the International Aerospace Abstracts data base). Report for September 1972-January 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 135p. Available from NTISPC N01/MF N01.

U.S. sales only.

This bibliography contains citations concerning the effects of sunspot activity on the Earth's magnetic field, atmosphere, and climate. Articles include experimental observations of solar-terrestrial effects correlating with sunspot activity; historical data in support of direct effects; and short- and long-term geomagnetic, atmospheric, and climatic effects of observed sunspot activity. Tree ring data, glacial measurements, ozone measurements, ocean floor coring, sea level changes, and other data are cited as examples of effects on Earth's environment caused by sunspot activity. (Contains 313 citations fully indexed and including a title list.)

29332 (RRK–89-30) **Teichmueller motion of (2+1)-dimensional gravity with the cosmological constant.** Fujiwara, Yoshihisa; Soda, Jiro. Hiroshima Univ., Takehara (Japan). Research Inst. for Theoretical Physics. Aug 1989. 27p. Order Number

DE90777745. Available from NTIS (US Sales Only), PC A03/MF A01.

The (2+1)-dimensional Einstein gravity with a cosmological constant is studied in the ADM canonical formalism. Adopting the York's time slice, we completely solve the initial-value problem and the time evolution equations with an initial spacelike 2-surface being a closed Riemann surface of genus zero and one. The result in a torus case is that the Teichmueller parameters for the torus follow a geodesic in the Teichmueller space but its motion asymptotically stops due to the presence of the cosmological constant. (author).

29333 (UCRL-JC–103348) **Update on the OPAL opacity code.** Rogers, F.J.; Iglesias, C.A.; Wilson, B.G. Lawrence Livermore National Lab., CA (USA). 23 Feb 1990. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-891052–2: Atomic processes in plasmas, Gaithersburg, MD (USA), 2-5 Oct 1989). Order Number DE90009946. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Persisting discrepancies between theory and observation in a number of astrophysical properties has led to the conjecture that opacity databases may be inaccurate. The OPAL opacity code has been developed to address this question. The physical basis of OPAL removes several of the approximations present in past calculations. For example, it utilizes a much larger and more detailed set of atomic data than was used to construct the Los Alamos Astrophysical Library. This data is generated online, in LS or intermediate coupling, from prefitted analytic effective potentials and is of similar quality as single configuration, relativistic, self-consistent-field calculations. The OPAL code has been used to calculate opacities for the solar core and for Cepheid variable stars. In both cases, significant increases in the opacity compared to the Los Alamos Astrophysical Library were found. 37 refs., 2 figs., 1 tab.

29334 On the Phase transition to spacetime in string cosmology. Axenides, M. (Univ. of Washington, Seattle (USA)). *General Relativity and Gravitation (USA),* 21(7): 659-664 (Jul 1989).

Closed string models have recently been constructed in lower than their critical spacetime dimensions D { <=} D_{cr}. An ideal gas of closed strings with D { >=} 4 undergoes a phase transition at a universal point (Hagedorn temperature). The authors argue that solitonic configurations on the string world-sheet (vortices) drive the system into a high-temperature phase where the vacuum is dominated by vortex condensates. Flat spacetime is identified with the dipole low-temperature phase of vortex antivortex pairs. This is a Kosterlitz-Thouless transition on the string world-sheet. It is suggestive of a stringy realization of the inflationary universe paradigm.

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Refer also to citation(s) 29331

29335 (AD-A–216440/8/XAB) **Processing of DMSP magnetic data and its use in geomagnetic field modeling. Report for 1 October 1987-30 September 1989.** Ridgway, J.R.; Sabaka, T.J.; Chinn, D.; Langel, R.A. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. Nov 1989. 63p. (SCIENTIFIC–1). Available from NTIS, PC A04/MF A01.

The DMSP F-7 satellite is an operational Air Force meteorological satellite which carried a magnetometer for geophysical measurements. The magnetometer was located within the body of the spacecraft in the presence of large spacecraft fields. In addition to stray magnetic fields, the data have inherent position and time inaccuracies. Algorithms were developed to identify and remove time varying magnetic field noise from the data. Techniques developed for Magsat were then modified and used to attempt determination of the spacecraft fields, of any rotation between the magnetometer axes and the spacecraft axes, and of any scale changes within the magnetometer itself. The corrected data were then used to attempt to model the geomagnetic field. This was done in combination with data from Magsat, from the standard magnetic observatories, from aeromagnetic and other survey data, and from DE-2 spacecraft magnetic field data. The results obtained are inconsistent and contradictory. Characterization of the problem is clearest when model coefficients are compared between models with DMSP data only and models with other data types only. In that case the gl(1) term in the DMSP models is consistently lower in magnitude by 10-25 nT from the trend inferred from models based on other data.

29336 (AD-A–216626/2/XAB) **Three-dimensional cloud dynamics: Preliminary application to a HANE (High Altitude Nuclear Explosions) environment. Interim report.** Huba, J.D.; Drake, J.F.; Mulbrandon, M. Naval Research Lab., Washington, DC (USA). 30 Jan 1989. 31p. (NRL-MR–6391). Available from NTIS, PC A03/MF A01.

The Defense Nuclear Agency is sponsoring a broad-based research program on the dynamics and phenomenology of high altitude nuclear explosions (HANEs). An important goal of this research is to understand and model the late time nuclear environment; specifically, the intense field-aligned striations which are produced. These striations are regions of high electron density and are of military significance because they can adversely impact communication and surveillance systems. Of particular interest to DNA is the development of a model which characterizes the power spectral density of nuclear striations: the outer scale, the freezing scale, the inner scale, and the associated power law exponents between these scale sizes. This information provides a description of the late time nuclear environment which can be used in propagation codes relevant to military systems. This document describes 3D plasma cloud dynamics model of Drake et al. (1988) which is applied to barium clouds and to nuclear striations. Quantitative estimates of the critical scale size for marginal stability are presented. The implications of these results regarding the freezing of plasma striations are discussed.

29337 (AD-A–216755/9/XAB) **Critical evaluation of the AE indices.** Kroehl, H.W. National Oceanic and Atmospheric Administration, Boulder, CO (USA). Environmental Research Labs. 1989. 14p. Available from NTIS, PC A03/MF A01.

Pub. in Jnl. of Geomagnetism and Geoelectricity, Vol. 41, 317-329(1989).

The computation of the total eastward and westward auroral electrojets from numerical modeling techniques for three different intervals during disturbed conditions provides a unique opportunity to evaluate the accuracy of the standard Auroral Electrojet indices AU(12) and AL(12). The effect on the indices of replacing the local magnetic coordinate system with a global system, of increasing the latitudinal coverage by increasing the number of stations from 12 to 57, and of integrating the current density to obtain the total current is considered as new indices are correlated with the standard ones. We conclude that AL(12) is a reasonable measure of the westward electrojet current in a statistical sense, that Au(12) is not as good a measure of the eastward current, and that values of AU(12) and AL(12) during quiet conditions, i.e., less than 50 nT, must be treated separately from disturbed conditions. It should also be noted that a rotation of the perturbation vectors into a global coordinate system improves the indices more than an increase in the number of stations. Reprints. (rrh)

29338 (AD-A–216867/2/XAB) **Active probing of space plasmas. Final report, 25 October 1985-30 September 1989.** Chan, C.; Silevitch, M.B.; Villalon, E. Northeastern Univ., Boston, MA (USA). 1 Sep 1989. 110p. Available from NTIS, PC A06/MF A01.

During the course of the research period our efforts were focused on the following areas: (1) An examination of stochastic acceleration mechanisms in the ionosphere; (2) A study of nonequilibrium dynamics of the coupled magnetosphere - ionosphere system; and (3) Laboratory studies of active space experiments. Reprints include: Dynamics of charged particles in the near wake of a very negatively charged body – Laboratory experiment and numerical simulation; Laboratory study of the electron temperature in the near wake of a conducting body; New model for auroral breakup during substorms; Substorm breakup on closed field lines; New model for substorm on sets – The pre-breakup and triggering regimes; Model of the westward traveling surge and the generation of Pi 2 pulsations; Ionospheric electron acceleration by electromagnetic waves near regions of plasma resonances; Relativistic particle acceleration by obliquely propagating electromagnetic fields; Some consequences of intense electromagnetic wave injection into space plasmas.

29339 (CONF-8710514–1) **Quasineutral beam propagation in space.** Papadopoulos, K.; Mankofsky, A.; Drobot, A. Science Applications International Corp., McLean, VA (USA). [1987]. 37p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC03-85SF15935. From Chapman conference; Sendai (Japan); 12-16 Oct 1987. Order Number DE90009459. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The propagation of dense energetic neutralized ion beams or plasmoids injected into a plasma across the ambient magnetic field under ionospheric conditions is considered. Using a simple physical model supported by two-dimensional hybrid simulations, it is shown that think dense beams can propagate ballistically over lengths many times their gyroradius. This occurs when the following conditions are satisfied: $\Delta/R_o \ll 1$, where Δ is the cross field beam width and R_o the gyroradius of an ambient ion having a velocity equal to the beam velocity u_b, and $n_bM_b/n_oM_o \gg 1$, where $n_b(M_b)$, $n_o(M_o)$ are the density (mass) of beam and ambient ions. The scaling of the ballistic propagation lengths and times with beam and ambient parameters is presented along with comments on the applicability of the model to space and astrophysics. 13 refs., 19 figs., 1 tab.

29340 (LA-UR–90-906) **Hf propagation through actively modified ionospheres.** Argo, P.E. (Los Alamos National Lab., NM (USA)); Fitzgerald, T.J.; Wolcott, J.H.; Simons, D.J.; Warshaw, S.; Carlson, R. Los Alamos National Lab., NM (USA). [1990]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-9005150–1: Ionospheric effects symposium, Washington, DC (USA), 1-3 May 1990). Order Number DE90008931. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have developed a computer modeling capability to predict the effect of localized electron density perturbations created by chemical releases or high-power radio frequency heating upon oblique, one-hop hf propagation paths. We have included 3-d deterministic descriptions of the depleted or enhanced ionization, including formation, evolution, and drift. We have developed a homing ray trace code to calculate the path of energy propagation through the modified ionosphere in order to predict multipath effects. We also consider the effect of random index of refraction variations using a formalism to calculate the mutual coherence functions for spatial and frequency separations based upon a path integral solution of the parabolic wave equation for a single refracted path through an ionosphere which contains random electron density fluctuations. 5 refs., 8 figs.

29341 Substorms, plasmoids, flux ropes, and magnetotail flux loss on March 25, 1983: CDAW 8. Fairfield, D.H. (Laboratory for Extraterrestrial Physics, NASA Goddard Space Flight Center, Greenbelt, Maryland (USA)); Baker, D.N.; Slavin, J.A.; Craven, J.D.; Frank, L.A.; Elphic, R.C.; Fennell, J.F.; Richardson, I.G. *Journal of Geophysical Research (USA)*, 94(A11): 15135-15152 (1 Nov 1989).

During a 9-hour period following a storm sudden commencement on March 25, 1983, six spacecraft near geosynchronous orbit, one over the pole, and three in the magnetotail monitored a complex sequence of magnetospheric variations. Magnetic field compressions associated with the sudden commencement were seen first by the three downtail spacecraft with increasing time delays that were consistent with the tailward movement of an interplanetary-shock- associated pressure enhancement. Ground magnetograms and synchronous orbit data are used to identify seven substorm intensifications during this geomagnetically active period. Six of these intensifications are clearly associated with tail lobe field decreases ~18 R_E behind the Earth. Four of these intensifications are followed by both B_z field increases in the tail lobes at ~18 and ~30 R_E and by the subsequent observation of rapidly flowing plasma sheet plasma at ISEE 3 ~110 R_E down the tail. During two substorms where DE 1 was optically observing the auroral oval, the area of the polar cap was observed to decrease as the tail lobe field decreased at 18 R_E. All these observations are consistent with the substorm-associated release of a plasmoid at a neutral line near 20 R_E; however, the classical north-south variation of the plasma sheet magnetic field thought to be characteristic of the passage of a plasmoid in the deep tail was not seen in every case. © American Geophysical Union 1989

29342 Electromagnetic instabilities in the plasma sheet boundary layer. Angelopoulos, V. (Department of Physics and Institute for Geophysics and Planetary Physics, University of California, Los Angeles (USA)); Elphic, R.C.; Gary, S.P.; Huang, C.Y. *Journal of Geophysical Research (USA)*, 94(A11): 15373-15384 (1 Nov 1989).

Plasma and magnetic field data observed during two ISEE crossings of the plasma sheet boundary layer are studied in conjunction with a linear stability theory analysis. The plasma distribution functions exhibit three distinct potential sources of free energy: ion/ion relative drifts, electron/ion relative drifts corresponding to a nonzero field-aligned current, and large ion temperature anisotropies. These observed distributions are used as source functions in a linear Vlasov theory of electromagnetic instabilities at propagation parallel or antiparallel to the average magnetic field. The theory shows that the field-aligned current gives rise to the low frequency kink-like instability, and anisotropies of the flowing ion components give rise to two distinct branches of the ion cyclotron anisotropy instability with spacecraft frame frequencies both below and above the proton cyclotron frequency Ω_p. Analysis of the magnetic field data demonstrates that the appearance of two fast, counterstreaming, anisotropic ion components corresponds to a significant increase in the magnetic fluctuation energy density both below and above Ω_p, in full agreement with the theoretical predictions. © American Geophysical Union 1989

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Refer also to citation(s) 27947, 28086, 28424, 28425, 28433, 28499, 28509, 28510, 28511, 28564, 28589, 28614, 28675, 28764, 28892, 28935, 29333, 29502, 29514, 29515, 29520, 29521, 29532, 29536, 29561, 29562, 29564, 29566, 29592, 29593, 29594, 29842

29343 (AD-A–216469/7/XAB) **Merged-beam studies into the mechanisms of hydrogen molecular ion recombination. Final report, 1 September 1987-31 August 1989.** Mitchell, J.B. University of Western Ontario, London, ON (Canada). Dept. of Physics. 30 Sep 1989. 31p. Available from NTIS, PC A03/MF A01.

Measurements of the dissociative Recombination and Excitation of HeH(+), the dissociative excitation of H3(+), the branching ratio for the decay channels for H(+)(3) (v= O) recombination and the cross section for the recombination of H2(+) (v = O) have been performed and are described here. A discussion of the relevance of these measurements to the recombination of H3(+) (v = O) is given. Canada.

29344 (AD-A–216470/5/XAB) **Surface production of ions. Final scientific report, 1 August 1986-30 September 1989.** Seidl, M. Stevens Inst. of Tech., Hoboken, NJ (USA). Dept. of Physics and Engineering Physics. 9 Oct 1989. 145p. Available from NTIS, PC A07/MF A01.

It has been shown that negative hydrogen ions can be produced with high efficiency by backscattering low energy (order of 1 eV) hydrogen atoms or ions from low work-function (less than 1.5 eV) surfaces. This has been demonstrated experimentally by backscattering the Maxwellian tail of thermally produced hydrogen atoms from a variety of low work function surfaces. The general nature of the electron transfer process has been described by a simple theoretical model. Low incident energy guarantees low energy spread of the negative hydrogen ions. It also makes it possible to consider a variety of adsorbates for reducing the work function of the converter surface. The work function of cesium-oxygen films on silicon can be as low as 0.9 eV but these films are too delicate for use on converter surfaces. Thick cesium oxide films with a work function ranging from 1.2 to 1.4 eV have been successfully used on converter surfaces. Surface production of cesium ions from solid electrolyte sources has been investigated. Three types of cesium ion guns were developed and used in the experiments.

29345 (AD-A–216599/1/XAB) **Determining the effects of microwave power and C-field setting on the frequency of a cesium atomic frequency standard. Technical report.** Karuza, S.K.; Johnson, W.A.; Voit, F.J. Aerospace Corp., El Segundo, CA (USA). Electronics Research Lab. 31 Dec 1989. 27p. (TR–0089(4470-03)-1). Available from NTIS, PC A03/MF A01.

In experiments at the United States National Institute of Standards and Technology, Andrea De Marchi showed that there exist optimum values of the C-field setting in a commercial dual-beam cesium frequency standard that make the output frequency insensitive to variations in microwave power. Moreover, and most important, De Marchi demonstrated that the long-term stability of the clock is improved if the C-field is set at one of these optimum settings. To see if these results can be obtained with a clock having a different modulation scheme, the authors, using a completely automated measuring system, performed a similar study on another manufacturer's commercial cesium standard; this standard employed single-beam tube optics and a modulation scheme different from that used by the clocks studied by De Marchi. Our results, similar to those of De Marchi, show that optimum C-field settings exist for the standard we investigated.

29346 (CONF-900289–4) **Negative ion formation processes: A general review.** Alton, G.D. Oak Ridge National Lab., TN (USA). [1990]. 36p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International workshop on the polarized ion sources and polarized gas jets; Tsukuba-Shi (Japan); 12-17 Feb 1990. Order Number DE90009809. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The principal negative ion formation processes will be briefly reviewed. Primary emphasis will be placed on the more efficient and universal processes of charge transfer and secondary ion formation through non-thermodynamic surface ionization. 86 refs., 20 figs.

29347 (CONF-900466–15) **Interatomic forces and bonding mechanisms in MgO clusters.** Wright, N.F.; Painter, G.S. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90010148. Available from NTIS, PC A02/MF A01; OSTI; INIS.

We report results from a first-principles local spin density quantum mechanical study of the energetics and elastic properties of a series of magnesium-oxygen clusters of various morphologies. The role of quantum effects, e.g. covalency, in the bonding character of diatomic MgO is determined by comparison of classical and quantum restoring force curves. The dependence of binding properties on geometry and metal to oxygen ratio is determined by comparison of binding energy curves for a series of clusters. Results show that while gross features of the binding curves may be represented by simple interatomic potentials, details require the many body corrections of a full quantum treatment. 6 refs., 5 figs.

29348 (IPPCZ–293/I, pp. 140-142) **Electrical measurements of a positive streamer development and its interaction with the cathode.** Cernak, M. (Komenskeho Univ., Bratislava (Czechoslovakia). Matematicko-Fyzikalna Fakulta). Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The term positive streamer covers the filamentary cathode-directed wave of ionization occurring in many electric discharges. Its propagation through the gas is highly influenced by space-charge field enhancements. Both experimental and theoretical studies of the phenomenon are briefly surveyed and the associated difficulties discussed. The aim of the paper is to point out that the use of a negative point/plane electrode geometry simplifies the problem and makes it possible to study the early stages of streamer development as well as the streamer-cathode contact. (J.U.).

29349 (LYCEN–89-06) **Delta excitation in nuclei: the lesson of charge exchange reactions.** Delorme, J. (Lyon-1 Univ., 69 - Villeurbanne (FR). Inst. de Physique Nucleaire); Guichon, P.A.M. Lyon-1 Univ., 69 - Villeurbanne (France). Inst. de Physique Nucleaire. 1989. 25p. (CONF-8903172–: 10. two-yearly meeting on nuclear physics, Aussois (France), 6-10 Mar 1989). Order Number DE90770342. Available from NTIS (US Sales Only), PC A03/MF A01.

We present an attempt of theoretical interpretation of charge exchange reactions on nuclei in the region of the delta resonance. Special care is taken to insure consistency with the constraints from pion and photon excitation channels. Good agreement with measured spectra can be obtained for all types of targets and incident ions except for polarized deuterons data which appear hardly reconcilable with the others within our interpretation. Despite the peripheral character of these reactions, a sizeable part of the observed downward shift of the resonance is possibly ascribable to a yet undetected collective mode of the nucleus at high excitation, the pionic branch. Our limited commitment is due to uncomplete knowledge of the NN $\rightarrow$ N Δ interaction and the transition form factors of the probing ions which has been palliated by some phenomenology.

29350 (N–90-16482) **General contraction of Gaussian basis sets. Part 2: Atomic natural orbitals and the calculation of atomic and molecular properties.** Almloef, J.; Taylor, P.R. Minnesota Univ., Minneapolis, MN (USA). 1989. 38p. (NASA-CR–186201;NAS–1.26:186201). Available from NTIS, PC A03/MF A01.

A recently proposed scheme for using natural orbitals from atomic configuration interaction (CI) wave functions as a basis set for linear combination of atomic orbitals (LCAO) calculations is extended for the calculation of molecular properties. For one-electron properties like multipole moments, which are determined largely by the outermost regions of the molecular wave function, it is necessary to increase the flexibility of the basis in these regions. This is most easily done by uncontracting the outmost Gaussian primitives, and/or by adding diffuse primitives. A similar approach can be employed for the calculation of polarizabilities. Properties which are not dominated by the long-range part of the wave function, such as spectroscopic constants or electric field gradients at the nucleus, can generally be treated satisfactorily with the original atomic natural orbital (ANO) sets.

29351 (N–90-16483) **Theoretical investigations of the structures and binding energies of Be(sub n) and Mg(sub n) (n = 3-5) clusters.** Lee, T.J.; Rendell, A.P.; Taylor, P.R. National Aeronautics and Space Administration, Moffett Field, CA (USA). Ames Research Center. 1989. 23p. (NASA-TM–101931;NAS–1.15:101931). Available from NTIS, PC A03/MF A01.

Researchers determined the equilibrium geometries and binding energies of Be and Mg trimers, tetramers and pentamers using single and double excitation coupled cluster (CCSD) and complete active space self-consistent-field (CASSCF) multireference configuration interaction (MRCI) wave functions in conjunction with extended atomic basis sets. Best estimates of the cluster binding energies are 24, 83 and 110 kcal/mole for Be3, Be4 and Be5; and 9, 31 and 41 kcal/mole for Mg3, Mg4 and Mg5, respectively. A comparison of the MRCI and CCSD results shows that even the best single-reference approach (limited to single and double excitations) is not capable of quantitative accuracy in determining the binding energies of Be and Mg clusters.

29352 (NAC-AR–86-01, pp. 205-207) **Atomic physics: Beam-foil spectroscopy.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Beam-foil spectroscopy is a well-established technique for exciting outer-shell transitions which are generally not observable by other spectroscopic techniques. Energetic heavy-ion beams are accelerated by the Van de Graaff accelerator. Outer-shell excitations are induced by passing the beam through a thin carbon foil. The de-excitation radiation in the visible to ultraviolet region is observed in an optical spectrometer. The projects described in this section have investigated atomic spectra for ionised oxygen atoms. 2 tabs., 12 refs.

29353 (RCNP-P–106, pp. 1-5) **The effects of charge dependence and asymmetry of nuclear forces on the mass difference of ^{3}H and ^{3}He.** Wu, Y. (Tohoku Univ., Sendai (Japan). Dept. of Physics); Ishikawa, S.; Sasakawa, T. Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.*

Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

Published in summary form only. TRITIUM/nuclear forces; TRITIUM/mass difference; HELIUM 3/nuclear forces; HELIUM 3/mass difference; TRITIUM; FADDEEV EQUATIONS; COULOMB FIELD; BINDING ENERGY; POTENTIAL ENERGY; NUCLEAR RADII; CHARGES

29354 (RCNP-P--106, pp. 109-112) **Excited state of He_4 molecule.** Maeda, Shuji (Obihiro Zootechnical Coll., Hokkaido (Japan)). Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289--: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

Published in summary form only. HELIUM/excited states; HELIUM/potential energy; HELIUM; INTERACTIONS; ELECTRON CORRELATION; FADDEEV EQUATIONS; GROUND STATES; HILBERT SPACE; MATHEMATICAL MODELS

29355 (SAND--90-0202) **Parametric dependences of the 2.63 and 2.65 μm laser lines of atomic xenon.** Brannon, P.J.; Patterson, E.L.; Samlin, G.E. Sandia National Labs., Albuquerque, NM (USA). Apr 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90008203. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Preliminary results for the parametric dependences of the 2.63 and 2.65 μm lines of a high-pressure xenon laser are given. The power deposition is varied from 200 to 800 W/cm^3 for gas mixtures of Ar(830 Torr)/Xe(4 Torr), Ar(750 Torr)/Xe(83 Torr) and Ar(621 Torr)/He(210 Torr)/Xe(4 Torr). The 2.65 μm line dominates the 2.63 μm line for all gas mixtures and the ratio of the 2.63 μm line intensity to that for the 2.65 μm line is suppressed by the higher concentration of xenon. 13 refs., 4 figs.

29356 (UCRL--21296) **Improved crystal bending techniques applied to the LLNL dual-arm Johann mounting x-ray spectrometer: Final report.** Silver, J.D. (Oxford Univ. (UK). Clarendon Lab.); Chantler, C.T. Lawrence Livermore National Lab., CA (USA); Oxford Univ. (UK). Clarendon Lab. [1990]. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90009528. Available from NTIS, PC A03/MF A01 - OSTI.

Earlier investigations using the LLNL Spectrometer have revealed several limitations to the resolution of observed spectral lines. The first is the broadening due to the finite target source, together with secondary effects due to the bowing of the target. Other limitations relate to the target and spectrometer geometry, and in particular to the small (2R = 30cm) Rowland Circle radius. At small radii the production of a 'perfect' curvature becomes increasingly difficult as distortions of the mosaic spread of crystallite angles are introduced by the stress. This is particularly true of lattice planes with three non-zero Miller indices (e.g. Si111 compared to Si220) and of stiff or thick crystals (e.g. silicon and quartz, which will shatter if >0.2mm crystals are bent to this radius), but small broadening and asymmetrical shifts are also introduced for other crystals. Conversely, soft crystals (such as thin PET) will bend readily to the radius but distort and relax in mountings with fixed bending forces. This report addresses a set of improvements to the bending techniques for both soft and stiff crystals. The first and most important development is the use of parallel, vertical posts and (symmetrical) bending points driven by micrometers instead of the earlier formed (i.e. pressed) crystals. The primary advantage is that the curvature from a small number of stress points is calculable, reproducible and does not introduce random stresses and distortions over the surface. The major methods used include the 2-point, 2-bar mount and the 4-point, 4-bar method. Various 4-point, 2-bar methods were also used. 14 figs.

29357 (UCRL-CR--103296) **High resolution stimulated Raman-Brillouin spectroscopy in gases and solids.** Bischel, W.K. (SRI International, Menlo Park, CA (USA). Molecular Physics Lab.); Dyer, M.J.; Faris, G.W.; Hickman, A.P.; Jusinski, L.E. Lawrence Livermore National Lab., CA (USA); SRI International, Menlo Park, CA (USA). Molecular Physics Lab. Dec 1989. 4p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90009535. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

High resolution, quasi-cw, stimulated Raman-gain spectroscopy has become a standard technique for the study of molecular energy levels. In this paper we apply this technique to the study of two diverse problems: a determination of the ac Stark effect for the vibrational levels of H_2, and a demonstration of the first high resolution stimulated Brillouin gain spectra in glasses and crystals. 7 refs., 3 figs.

29358 (UCRL-CR--103380) **Correlated electron processes in ion-atom collisions: Final report, September 8, 1988--August 31, 1989.** McColm, D.W. (California Univ., Davis, CA (USA). Dept. of Physics). Lawrence Livermore National Lab., CA (USA); California Univ., Davis, CA (USA). Dept. of Physics. 1 Feb 1990. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90009477. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This final report covers the work carried out under the LLNL Contract P.O. Number B055762, Subcontractor Regents University of California at Davis. The research carried out under this contract investigated electron processes occurring in collisions between heavy ions and atoms. The doubly-differential secondary electron yield following the impact of 3.5 to 8 MeV/uU^{q+}(q = 38,68) ion impact on thin carbon foil targets has been investigated experimentally. The absolute electron emission yields were determined for ejection angles varied between 22.5° and 157° and electron energies ranging from 10 eV to 8 keV. The electron spectra are compared to previous investigations and new experimental data using lighter ion impact at MeV projectile energies. 14 refs., 5 figs.

29359 (UCRL-ID--103424) **The 1989 Livermore Evaluated Photon Data Library (EPDL).** Cullen, D.E.; Perkins, S.T.; Rathkopf, J.A. Lawrence Livermore National Lab., CA (USA). Mar 1990. 65p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008190. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This paper describes the contents of the 1989 Livermore Evaluated Photon Data Library (EPDL) as well as the sources of data, the evaluation methods and how to interpret and use the data. This library contains data for the elements H through Fm, Z = 1 -- 100, over the energy range 10 eV to 100 GeV. For each element cross sections, form factors, coherent anomalous scattering factors and the average energy of all secondary particles are given. 27 refs., 28 figs., 2 tabs.

29360 A new model for the simulation of interfaces at high temperature. Lutsko, J. F. (Materials Science Div., Argonne National Lab., Argonne, IL (US)); Ngayen, T.; Phillpot, S.R.; Wolf, D.; Yip, S. pp. 609 of Interfacial structure, properties and design. Yoo, M.H.; Clark, W.A.T.; Briant, C.L. Materials Research Society, Pittsburgh, PA (USA) (1988). DOE Contract W-31-109-ENG-38. (CONF-8804112--: Interfacial structure, properties and designs in solids, Reno, NV (USA), 5-9 Apr 1988).

A new method for the molecular dynamics simulation of bulk planar interfaces at high temperatures is presented. The method uses the basic Parrinallo-Rahman (constant stress) scheme modified, however, for the application to inhomogeneous systems. Since our computational cell contains only one interface with 2-d periodic boundary conditions we are able to study isolated interfaces all the way up to melting. The interaction between boundaries which may lead to their annihilation at higher temperatures, which is a problem when 3-d periodic boundaries are applied, is thus avoided. As an application, the method is used to study the stability of a grain boundary at high temperatures. Observations on a possible connection between grain boundary migration and premelting are discussed.

29361 NEXAFS studies of unsaturated carboxylic acids and alcohols adborsed on the Si(lll)(7 x 7) surface. Outka, D.A. (Stanford Univ. Stanford, CA (USA)); Stohr, J.; Madix, R.J.; Rotermund, H.H.; Hermsmeier, B.; Solomon, J. pp. 811 of Interfaces, superlattices, and thin films 65491. Dow, J.D.; Schuller, I.K.

Materials Research Society, Pittsburgh, PA (USA) (1987). (CONF-8612131–: Materials Research Society symposium on interfaces, superlattices and thin films, Boston, MA (USA), 1-6 Dec 1986).

The authors present the adsorption of formic (HCOOH), acrylic (CH_2 = CHO_2H), propiolic acid (HC ≡ CCO_2H), and the corresponding alcohols on the Si(III) (7 × 7) surface investigated by NEXAFS. In each case, well-defined dipole transactions were observed above the C and O K-edges and used to probe the orientation and chemistry of theses molecules on this silicon surface. Results illustrate the capabilities of NEXAFS to investigate molecular orientations on surface and the electronic structure of polyatomic adsorbates.

29362 Non-Abelian geometric phase and long-range atomic forces. Zygelman, B. (Institute for Theoretical Physics, University of California at Santa Barbara, Santa Barbara, California 93106 (US)). *Physical Review Letters (USA)*, 64(3): 256-259 (15 Jan 1990).

Using fully quantal methods, we investigate various manifestations of the geometric phase in bound and free diatom systems. Adiabaticity and degeneracy are not invoked in the discussion.

29363 Photoelectron spectroscopy and electronic structure of heavy group IV–VI diatomics. Wang, L. (Department of Chemistry, University of California—Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, California 94720 (USA)); Niu, B.; Lee, Y.T.; Shirley, D.A.; Balasubramanian, K. *Journal of Chemical Physics (USA)*, 92(2): 899-908 (15 Jan 1990). DOE Contract AC03-76SF00098.

Vibrationally resolved HeI (584 A) photoelectron spectra of the heavy group IV–VI diatomics SnSe, SnTe, PbSe, and PbTe were obtained with a new high temperature molecular beam source. Ionization potentials and spectroscopic constants are reported for all the ionic states observed. Relativistic complete active space multiconfiguration self-consistent field (MCSCF) followed by multireference singles+doubles relativistic configuration interaction (CI) calculations which included up to 200 000 configurations were made on both the neutral diatomics and their positive ions. Ionization potentials and spectroscopic constants were calculated and were in good agreement with the experimentally measured values. Relativistic CI potential energy curves were calculated for all the neutral ground states and the ionic states involved. Relativistic effects were shown to play an important role in these heavy diatomics. The $^2\Sigma^+_{1/2}$ and $^2\Pi_{1/2}$ states for all four molecular ions showed avoided curve crossings, which resulted in pronounced shoulders in the Ω=1/2 potential energy curves of $PbTe^+$. Experimentally, autoionization transitions were also observed for the $PbTe^+$ spectrum. The importance of the relativistic effect and chemical bonding in the heavy diatomics are discussed.

29364 Reduced dimensionality diatom–diatom reactive scattering: Application to a model $H_2+A_2 \rightarrow H+HA_2$ reaction. Sun, Q. (Department of Chemistry, Emory University, Atlanta, Georgia 30322 (US)); Bowman, J.M. *Journal of Chemical Physics (USA)*, 92(2): 1021-1029 (15 Jan 1990). DOE Contract FG05-86ER13568.

We apply a recently formulated quantum theory of diatom–diatom reactions [Q. Sun and J. M. Bowman, Int. J. Quant. Chem., Quant. Chem. Symp. **23**, 9 (1989)] to a model collinear $H_2+A_2 \rightarrow H+HA_2$ reaction, where A has the mass of a hydrogen atom. The theory assumes one diatom bond is nonreactive, and the reactive scattering Hamiltonian is written in terms of hyperspherical and cylindrical coordinates. The potential-energy surface used is the PK2 $H+H_2$ surface augmented by a harmonic degree of freedom describing the nonreactive A_2. Details of the formulation and solution of the coupled-channel equations are given, along with convergence tests, and a discussion of the new state-to-state transition probabilities. In particular, the partial quenching of the well-known collinear $H+H_2$ resonances is noted.

29365 The infrared spectrum of trimethylenemethane. Predictions of in-plane vibrational frequencies from correlated wave functions. Blahous, C.P. III (Center for Computational Quantum Chemistry, University of Georgia, Athens, Georgia 30602 (US)); Xie, Y.; Schaefer, H.F. III. *Journal of Chemical Physics (USA)*, 92(2): 1174-1179 (15 Jan 1990). DOE Contract FG09-87ER13811.

The infrared vibrational spectrum of trimethylenemethane (TMM) is predicted with self-consistent field and configuration interaction methods. The $^3A'_2$ electronic ground state of TMM is described in terms of restricted Hartree–Fock theory and in light of experimental evidence. Analytic gradient methods are employed to optimize theoretical geometries for $^3A'_2$ TMM; vibrational frequencies are evaluated via analytic second-derivative techniques (self-consistent-field) and finite differences of analytic gradients (configuration interaction). The resulting IR-spectral predictions are modified to reflect average errors statistically associated with the two theoretical methods.

29366 Bulk properties from finite-cluster calculations. V. Pseudo-Wannier orbitals from molecular orbital calculations on finite clusters. Cioslowski, J. (Department of Chemistry and Supercomputer Computations, Research Institute, Florida State University, Tallahassee, Florida 32306-3006 (US)). *Journal of Chemical Physics (USA)*, 92(2): 1236-1239 (15 Jan 1990). DOE Contract FC05-85ER25000.

A unitary transformation of the canonical Hartree–Fock orbitals which yields pseudo-Wannier orbitals in periodic finite systems is introduced. These orbitals are localized within individual unit cells and therefore can serve as a suitable one-electron basis for calculating the electron correlation energy. They also provide a natural partitioning scheme which allows for studying the finite-size effects on the total energy and the first-order electronic properties. The similarity sum which is maximized by the above transformation can serve as a measure of deviation of the electronic distribution in the system under consideration from that of an infinite periodic system.

29367 Free energy and stability of macromolecules studied by the double scanning simulation procedure. Meirovitch, H. (Supercomputer Computations Research Institute, Florida State University, Tallahassee, Florida 32306-4052 (USA)); Vasquez, M.; Scheraga, H.A. *Journal of Chemical Physics (USA)*, 92(2): 1248-1257 (15 Jan 1990). DOE Contract FC05-85ER25000.

The double scanning method (DSM) is a computer simulation technique suggested recently by Meirovitch [J. Chem. Phys. **89**, 2514 (1988)]. This method is a variant of the usual or "single" scanning method (SSM) of the same author, which was extended by us to polypeptides [Biopolymers **27**, 1189 (1988); this paper is designated here as paper II]. The two methods are step-by-step construction procedures from which the entropy and the free energy can be estimated. The transition probabilities are obtained by scanning the so-called "future" chains, which are continuations of the chain in future steps up to a maximum of *b* steps. With the SSM, the process is carried out by exact enumeration of the future chains; this is time consuming, and therefore *b* is limited to small values. With the DSM, on the other hand, only a relatively small sample of the future chains is generated by applying an additional scanning procedure. This enables one to increase *b* at the expense of approximating the transition probabilities. Increasing of *b*, however, is important in order to treat medium- and long-range interactions more properly. In this paper (as in our paper II), we apply the DSM to a model of decaglycine without solvent, described by the potential energy function ECEPP at 100 and 300 K. Using the SSM with the maximal value, *b*=4, we found in paper II that, at 100 K, the α helix rather than the statistical coil is the most stable state. The present DSM simulation at *T*=100 K (based on *b*=5) is more efficient than the SSM, and a structure with significantly lower energy than that of the α helix is found. It is argued that *b* can be increased further to 7 at this temperature. At 300 K the DSM, like the SSM, shows that the statistical coil is the most stable state of decaglycine. However, the DSM is found to be less efficient than the SSM.

29368 Measurement of atomic indium during metalorganic chemical vapor deposition. Hebner, G.A. (Sandia National Laboratories, P.O. Box 5800, Albuquerque, New Mexico 87185 (US)); Killeen, K.P. *Journal of Applied Physics (USA)*, 67(3): 1598-1600 (1 Feb 1990).

Atomic indium, produced by the pyrolysis of trimethylindium (TMIn) during metalorganic chemical vapor deposition, has been directly observed using resonant fluorescence spectroscopy. The

indium fluorescence signal is linear with TMIn flow rate at a susceptor temperature of 500 °C above a small background threshold level. The threshold for the observation of an indium signal is 325 °C. Addition of trimethylantimony (TMSb) at concentrations less than those required for normal InSb epitaxial growth results in quenching of the indium signal.

29369 Observation of a SO^+_2 threshold photoelectron band in the energy range 14.4–15.5 eV. Norwood, K. (Ames Laboratory, U. S. Department of Energy—Department of Chemistry, Iowa State University, Ames, Iowa 50011 (USA)); Ng, C.Y. *Journal of Chemical Physics (USA)*, 92(2): 1513-1515 (15 Jan 1990). DOE Contract W-7405-ENG-82.

In orderto gain insight into the autoionization mechanisms of sulfur dioxide, the threshold photoelectron spectrum was measured in the wavelength region of 800–860 Angtroms.(AIP)

29370 Quantum state-resolved study of the rovibrational excitation of OCS by hot hydrogen atoms. Zhu, L. (Department of Chemistry and Columbia Radiation Laboratory, Columbia University, New York, New York 10027 (US)); Hershberger, J.F.; Flynn, G.W. *Journal of Chemical Physics (USA)*, 92(3): 1687-1695 (1 Feb 1990). DOE Contract FG02-88ER13937.

The vibrationally inelastic scattering of OCS by hot hydrogen atoms was studied using an excimer laser photolysis/diode laser probe technique. Nascent rotational distributions for the 10^00 (2062 cm^{-1}) and 00^01 (859 cm^{-1}) stretching vibrations are well fit to Boltzmann temperatures of 840±50 and 545±60 K, respectively. The total vibrational excitation probability of the 00^01 state was about 2.3±0.3 times that of the 10^00 state. Measurement of OCS linewidths immediately after hot atom collisions indicate translational recoil temperatures that vary from 360 to 730 K, with a positive dependence on rotational state. The results are interpreted in terms of repulsive, hard shell collisions with the different stretching vibrations arising from trajectories approaching different ends of the OCS molecule.

29371 Photodissociation and continuum resonance Raman cross sections and general Franck–Condon intensities from *S*-matrix Kohn scattering calculations with application to the photoelectron spectrum of $H_2F^- + h\nu \rightarrow H_2 + F$, $HF + H + e^-$. Zhang, J.Z.H. (Department of Chemistry, University of California, Berkeley, CA (US)— Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, Berkeley, California 94720 (US)); Miller, W.H. *Journal of Chemical Physics (USA)*, 92(3): 1811-1818 (1 Feb 1990). DOE Contract AC03-76SF00098.

It is shown how the *S*-matrix version of the Kohn variational method for quantum scattering can be readily adapted to compute matrix elements involving the scattering wave function and also matrix elements of the scattering Green's function. The former of these quantities is what is involved in computing photodissociation cross sections, photodetachment intensities from a bound negative ion to a neutral scattering state, or the intensity of any Franck–Condon transition from a bound state to a scattering state. The latter quantity (i.e., a matrix element of the scattering Green's function between two bound states) gives the resonance Raman cross section for the case that the intermediate state in the Raman process is a scattering state. Once the basic *S*-matrix Kohn scattering calculation has been performed, it is shown that little additional effort is required to determine these quantities. Application of this methodology is made to determine the electron energy distribution for photodetachment of H_2F^- to $F+H_2$, HF+H. Resonance structure in the $J=0$ reaction probabilities is seen to appear in the electron energy distribution.

29372 Rotational state distributions from vibrational autoionization of H_2 revisited. Pratt, S.T. (Argonne National Laboratory, Argonne, Illinois 60439 (US)); McCormack, E.F.; Dehmer, J.L.; Dehmer, P.M. *Journal of Chemical Physics (USA)*, 92(3): 1831-1838 (1 Feb 1990). DOE Contract W-31-109-ENG-38.

Photoelectron spectra of vibrationally autoionized $(X\ ^2\Sigma^+_g)np$, $v=1,2$ Rydberg states of H_2 were obtained by using an optical–optical double-resonance technique. The spectra were obtained by using a hemispherical electrostatic electron energy analyzer that had sufficient resolution to determine the rotational state distributions of the H^+_2 ions. The ionization process occurred in a magnetic and electric field-free region. All of the results are consistent with the assumptions that the photoelectrons are ejected as *p* waves and that spin effects are negligible. This is in sharp contrast to our earlier results obtained by using a magnetic bottle electron spectrometer, in which the ionization process occurred in a 0.5–1.0 T magnetic field [J. L. Dehmer *et al.*, J. Chem. Phys. **90**, 6243 (1989)]. It is concluded that the magnetic field can significantly modify the rotational distributions observed for vibrational autoionization. The implications of this conclusion are discussed, with particular attention to other experiments performed with the magnetic bottle spectrometer.

29373 Raman intensities and interference effects for thin films adsorbed on metals. Ager, J.W. III (Center for Advanced Materials, Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, Berkeley, California 94720 (US)); Veirs, D.K.; Rosenblatt, G.M. *Journal of Chemical Physics (USA)*, 92(3): 2067-2076 (1 Feb 1990). DOE Contract AC03-76SF00098.

Large oscillations in the vibrational Raman intensity have been observed for thin films adsorbed on a metal substrate as a function of film thickness. The systems studied, N_2 and O_2 physisorbed on Ag(111) at 14±1 K, have previously been shown to be unenhanced, i.e., the observations are not caused by the surface enhanced Raman (SERS) effect. The observed oscillations are due to multiple beam interference caused by reflections at the film boundaries of the incident laser light, and, to a lesser extent, the Raman scattered light. We extend the two-dimensional theoretical development of Moscovits and co-workers for Raman scattering in thin films to include more general three-dimensional experimental geometries. We derive expressions for the total intensity as a function of film thickness, incident laser polarization and angle, and scattered light polarization and angle. The resultant expressions are applicable to Raman scattering from any dielectric thin film adsorbed on a substrate with known optical parameters. Although complicated, the general expressions have been numerically evaluated for our experimental conditions using a commercial mathematical package on a personal computer. The calculated Raman intensities are in excellent agreement with the experimental results. The observed period of the intensity oscillation relates the film thickness to the exposure allowing the sticking probabilities to be determined. The sticking probabilities of N_2 on N_2 and O_2 on O_2 at 14±1 K are 0.84±0.2 and 0.82±0.2, respectively.

29374 Reply to the Comment on: "Lifetime of the $A\ ^2\Sigma^+$, $v'=0$ state of HS". Loge, G.W. (Chemical and Laser Sciences Division, Los Alamos National Laboratory, M.S.J567, P. O. Box 1663, Los Alamos, New Mexico 87545 (USA)); Tiee, J.J. *Journal of Chemical Physics (USA)*, 92(3): 2122 (1 Feb 1990).

The results of measurements of the lifetime of the excited states of SH, using Hanle effect and by measuring linewidths in LIF–molecular beam is explained.(AIP)

6404 Fluid Physics

Refer also to citation(s) 27531, 28958

29375 (DOE/ER/25061–6) **Analytical and numerical studies in flow development: Progress report, 1 July 1989 to present.** Criminale, W.O.; Adams, L.M. Washington Univ., Seattle, WA (USA). Dept. of Applied Mathematics. Mar 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG06-88ER25061. Order Number DE90010424. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Analytical bases have been established for a wide variety of shear flows under general initial conditions. In addition, provisions have been made for study of both spatial and temporal development of disturbances. This combination is the essential framework for eventual direct numerical simulation of the three major prototypes of flow, namely bounded (channel) flow; semi-infinite (boundary layer) flow; and unbounded (mixing layer) flows. Besides the asset of having closed form solutions in all spatial coordinates and time, the important transient (initial) state of the motion can be determined explicitly. Of particular note is the fact that nonlinearity can be triggered by algebraic growth of disturbances — and therefore an alternate route for the breakdown to turbulence is possible.

Such events have been termed "bypass" because they can occur in a shorter time (or spatial) scale than that of the more common asymptotic exponential growth due to the instability of the flow. It is for these reasons that the eventual kinking of the solutions to the numerical simulation is awaited with optimism.

29376 (SAND–89-1927C) **Partial acoustic filtering applied to the equations of compressible flow.** Torczynski, J.R. Sandia National Labs., Albuquerque, NM (USA). [1990]. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900651–1: International symposium on nonsteady fluid dynamics, Toronto (Canada), 4-7 Jun 1990). Order Number DE90000673. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Gas contained in a rectangular enclosure of large length and small width is subjected to large, transient, spatially nonuniform, volumetric heating. The heating timescale is much longer than the time required for an acoustic wave to traverse the width but can be comparable to the time required for an acoustic wave to traverse the length. Approximate equations are derived from the two-dimensional equations of mass, momentum, and energy conservation for a perfect gas without viscosity or thermal conductivity. This is accomplished by applying partial acoustic filtering to the equations of motion: pressure waves traversing the width are removed while pressure waves traversing the length are retained. The pressure is partitioned into the average pressure across the width, which is O(1), and the small remaining perturbation that is the difference between the pressure and its average. The resulting equations are hyperbolic for the average pressure term but are elliptic for the perturbation pressure term. If an explicit numerical method is used to solve the approximate system, the maximum allowable time step is potentially much larger than the time step for the original system, which is dominated by resolution of pressure waves propagating across the width. Application of partial acoustic filtering to three-dimensional geometries is discussed. 5 refs.

29377 (UCRL-ID–103198) **Index and consistency analysis for DAE [differential-algebraic equation] systems for Stefan-Maxwell diffusion-reaction problems.** Hindmarsh, A.C. Lawrence Livermore National Lab., CA (USA). 6 Mar 1990. 25p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008188. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The paper by Hindmarsh and Johnson discusses the formulation and solution of certain reaction-diffusion systems involving Stefan-Maxwell diffusion. This report is intended to provide supportive analytical results concerning the systems of differential-algebraic equations (DAEs) treated in that paper. The systems considered have only one reactant fluid, one product fluid, and one reactant solid; this restricted problem was chosen because the various solvability issues can be settled quite thoroughly. Of particular interest is the index of the DAE systems, the evaluation of consistent initial conditions, and the conservation of the sum of fluid mole fractions. 3 refs.

29378 (UCRL-JC–103243) **Plane Stokes flow driven by capillarity on a free surface: Overview and status.** Hopper, R.W. Lawrence Livermore National Lab., CA (USA). 11 Mar 1990. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-900684–1: 5. international colloquium on free boundary problems: theory and applications, Montreal (Canada), 13-22 Jun 1990). Order Number DE90009186. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This article summarizes some recent work on the creeping viscous incompressible plane flow in a region, bounded by a simple smooth closed curve and driven solely by surface tension. Such problems are self-contained in that the applied tractions are intrinsic in the geometry. The objective is to determine exactly the time evolution of the shape of the region. The problems are fundamentally nonlinear due to the large changes in shape, and it is emphasized that no mathematical approximations are made. For finite regions, the shape in the complex z-plane is described in terms of a time-dependent conformal mapping function $\Omega(\zeta,t)$ on the fixed region $||\zeta|| \leq 1$ of the complex. In practice, it has been necessary to conjecture an explicit parametric form $\Omega[\zeta;a_1(t), a_2(t),\cdots]$ whose validity must be verified using the shape-evolution equation. Suitable parameterizations are not always obvious. When the conjectured form hold and the equations can be solved, the equation of the shape with time is obtained in simple, exact and closed form except for the value of the time, which requires a mere quadrature. Internal velocity and stress field can be obtained. 6 refs., 2 figs.

29379 (UCRL-JC–103270) **Implementing the particle method on the IPSC/2.** Dougherty, D.E. (California Univ., Irvine, CA (USA). Dept. of Civil Engineering); Tompson, A.F.B. Lawrence Livermore National Lab., CA (USA). Feb 1990. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9006156–2: 8. international conference on computational methods in water resources, Venice (Italy), 11-15 Jun 1990). Order Number DE90009948. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Massively parallel computers, with numerous processor/memory elements connected by high-speed communication channels, will be the standard computing environment in the future. Efficient use of these resources requires algorithms that are well-matched to these architectures. The particle method for solute transport, utilizing a random walk technique for the dispersion term, is a naturally parallel algorithm for solving the advection-dispersion equation. Results of implementation of the random walk particle-grid method in three spatial dimensions on the Intel iPSC/2 are presented. Speedups are measured and high efficiency is obtained for the kernels tested. Future directions are discussed briefly. 8 refs., 3 tabs.

29380 **High Marangoni number convection in a square cavity: Part II.** Carpenter, B.M. (Department of Chemical Engineering, Stanford University, Stanford, California 94305 (US)); Homsy, G.M. *Physics of Fluids A (USA)*, 2(2): 137-149 (Feb 1990).

Steady thermocapillary flow is examined in a square two-dimensional cavity with a single free surface and differentially heated side walls. The numerical solutions are obtained with a finite difference method applied to a streamfunction-temperature formulation. This work investigates the Prandtl number dependence, structure, and stability of high Marangoni number flow. It is found that the character of thermocapillary flow is highly sensitive to the value of the Prandtl number over a range of Marangoni numbers exceeding 1×10^5 for $1\leq Pr\leq 50$, the magnitude of the flow showing nonmonotonic dependence on the Marangoni number for $Pr\leq\sim10$. A complete structural analogy is observed between flow in a cavity driven by a moving lid and thermocapillary flow in the boundary layer limit, and it is found that all the solutions, spanning a wide range of Marangoni and Prandtl numbers, are linearly stable to a restricted class of disturbances.

29381 **Collapsing solutions to the 3-D Euler equations.** Pumir, A. (Ecole Normale Superieure, Department de Physique, 24 rue Lhomond, 75231 Paris Cedex 05, France (FR)— C. E. N. Saclay, 91191 Gif-s/Yvette, France). *Physics of Fluids A (USA)*, 2(2): 220-241 (Feb 1990). DOE Contract AC02-83ER13044.

A three-dimensional adaptive mesh code is used to search for singularities in the incompressible Euler equations. For the initial conditions examined, the maximum vorticity eventually grows only exponentially. The small scales are quasi-two-dimensional and the vorticity has a pronounced tendency to develop sharp jumps in magnitude. The vorticity is very nearly parallel to the eigenvector of the rate-of-strain matrix whose eigenvalue is the smallest in magnitude. This eigenvalue is positive and much smaller than the others.

29382 **A diffusion model for velocity gradients in turbulence.** Girimaji, S.S. (Sibley School of Mechanical and Aerospace Engineering—Cornell University, Ithaca, New York 14853 (USA)); Pope, S.B. *Physics of Fluids A (USA)*, 2(2): 242-256 (Feb 1990).

In this paper a stochastic model for velocity gradients following fluid particles in incompressible, homogeneous, and isotropic turbulence is presented and demonstrated. The model is constructed so that the velocity gradients satisfy the incompressibility and isotropy requirements exactly. It is further constrained to yield the first few moments of the velocity gradient distribution similar to those computed from full turbulence simulations (FTS) data. The performance of the model is then compared with other computations from FTS data. The model gives good agreement of one-time statistics. While the two-time statistics of strain rate are well replicated, the two-time vorticity statistics are not as good, reflecting perhaps a

certain lack of embodiment of physics in the model. The performance of the model when used to compute material element deformation is qualitatively good, with the material line-element growth rate being correct to within 5% and that of surface element correct to within 20% for the lowest Reynolds number considered. The performance of the model is uniformly good for all the Reynolds numbers considered. So it is conjectured that the model can be used even in inhomogeneous, high-Reynolds-number flows, for the study of evolution of surfaces, a problem that is of interest particularly to combustion researchers.

29383 **A second-order projection method for the incompressible Navier–Stokes equations.** Bell, J.B. (Lawrence Livermore National Laboratory, Livermore, California 94550 (USA)); Colella, P.; Glaz, H.M. *Journal of Computational Physics (USA)*, 85(2): 257-283 (Dec 1989). DOE Contract W-7405-ENG-48.

In this paper we describe a second-order projection method for the time-dependent, incompressible Navier–Stokes equations. As in the original projection method developed by Chorin, we first solve diffusion-convection equations to predict intermediate velocities which are then projected onto the space of divergence-free vector fields. By introducing more coupling between the diffusion–convection step and the projection step we obtain a temporal discretization that is second-order accurate. Our treatment of the diffusion-convection step uses a specialized higher order Godunov method for differencing the nonlinear convective terms that provides a robust treatment of these terms at high Reynolds number. The Godunov procedure is second-order accurate for smooth flow and remains stable for discontinuous initial data, even in the zero-viscosity limit. We approximate the projection directly using a Galerkin procedure that uses a local basis for discretely divergence-free vector fields. Numerical results are presented validating the convegence properties of the method. We also apply the method to doubly periodic shear-layers to assess the performance of the method on more difficult applications. © 1989 Academic Press, Inc.

29384 **Chaotic characteristics of a complex gas-solids flow.** Daw, C.S. (Oak Ridge National Laboratory, Post Office Box 2009, Oak Ridge, Tennessee 37831-8087 (US)); Lawkins, W.F.; Downing, D.J.; Clapp, N.E. Jr. *Physical Review, A (General Physics) (USA)*, 41(2): 1179-1181 (15 Jan 1990).

We interpret experimental pressure-drop measurements from a complex gas-solids flow system in terms of recently developed methods for chaotic time-series analysis. The results strongly support the conjecture that the flow can be described by a low-dimensional strange attractor that changes as a key turbulence parameter is varied. The analysis methods also appear to permit clear separation of the chaotic and noise components in the signal.

6450 High Energy Physics

Refer also to citation(s) 29894

29385 (SLAC–343, pp. 7-30) **The τ-charm factory storage ring initial design and parameters.** Jowett, J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The initial design and parameters of the tau-charm factory storage ring is presented. The history of the machine design from January 1987 to May 1989 is included. Items in this report include: luminosity, micro-beta insertion and separation scheme, triplet focusing, injection and geometry, optics, rf system, parameter list, and variation of parameters with energy. An efficient, high-performance injection system is indicated as vital.

29386 (SLAC–343, pp. 31-41) **Crab-crossing in a tau-charm facility.** Voss, G.A.; Paterson, J.M.; Kheifets, S.A. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

Crab-Crossing in a tau-charm facility is reviewed. In a crab-crossing beam geometry (beam-crossing half-angle alpha), bunches are rotated by the angle alpha around their centers in deflecting RF cavities such that at the IP the two long axes of the bunches (along which phase oscillations take place) are colinear. This changes effectively the crossing beam geometry into a head-on collision geometry with a simultaneous transverse motion in the laboratory reference system. Horizontal versus vertical beam crossing is discussed. The design of a crab-crossing arrangement for a tau-charm facility is included. Tolerances, beam loading, and average current limitations are presented.

29387 (SLAC–343, pp. 90-112) **Status of the Tau one prong problem.** Hayes, K.G. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The present status of the tau one prong problem is reviewed. Emphasis is placed on recent published branching fraction measurements, the status and implications of tau lifetime measurements, and measurements which constrain the sum of branching fractions to be unity.

29388 (SLAC–343, pp. 113-126) **Rare tau decays.** Barish, B.C. (California Institute of Technology, Pasadena (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The possibilities and challenges for studying rare decays of the τ with the large data samples from a tau-charm factory are discussed. These studies involve expected decay of the τ like multihadronic channels, suppressed decays like 2nd class currents or Cabibbo suppression, and possible unexpected decays.

29389 (SLAC–343, pp. 127-151) **An overview of charmed meson physics accessible to a high luminosity collider operated near charm pair thresholds.** Schindler, R.H. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The second generation up-type quark, charm, may be the only quark for which Cabibbo allowed, singly Cabibbo forbidden, doubly Cabibbo forbidden, second order weak and perhaps even CP violating transitions will be measurable. The charm physics at the Tau-Charm Factory is thus organized along those lines, namely; weak hadronic decays (allowed thru doubly forbidden), pure and semi-leptonic decays (allowed and forbidden), rare decays, second order weak decays, and CP violating decays. The pure leptonic decays allow them to probe the quark overlap in the charm meson in a theoretically unambiguous fashion. These measurements would provide important benchmarks for Lattice QCD. The semileptonic decays provide information on the dynamics of heavy quark decay, one vertex being wholly uninfluenced by QCD. The full range of allowed, forbidden and doubly forbidden hadronic decays test their detailed understanding of the hadronic weak current and the contributions of perturbative and non-perturbative QCD to a heavy quark system. They clearly represent the most difficult processes to untangle, but benefit from the detailed studies of the leptonic and semileptonic processes accessible to the Tau-Charm Factory. The rare decays provide a test of the Standard Model (SM), and are

sensitive to the exchange of massive new (10-100s TeV) particles. Since couplings to new particles may be flavor dependent, these decays provide complementary information to that obtained in rare Kaon decay experiments. $D^0\bar{D}^0$ mixing is one of the few second order weak processes still accessible to experiment. It is potentially very interesting since its rate may be heavily influenced by the presence of intermediate states in the second order weak decay. The origin of CP violation remains a mystery to this day.

29390 (SLAC–343, pp. 169-195) **$D^0\bar{D}^0$ mixing and CP violation in D decays - Can there be high impact physics in charm decays?** Bigi, I.I. (Univ. of Notre Dame, IN (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The phenomenology of D^0-$\bar{D}^0$ mixing and of CP violation in D decays is described. Semiquantitative predictions based on the Standard Model are given on the possible strength of these phenomena. It is pointed out that New Physics beyond the Standard Model would probably enhance these phenomena in quite a significant way. To justify a New Initiative one has to be able to probe D^0-$\bar{D}^0$ mixing down to $r_D = 10^{-4}$ (or better) and CP asymmetries down to 1% (or better). It is of obvious benefit for such searches if one is able to track the proper time evolution of these decays by locating the decay vertices. Yet this can hardly be achieved if one uses e^+e^- annihilation operating in the charm threshold region. It is discussed in some detail how the same kind of dynamical information can be obtained even without visible decay vertices, namely by employing $D\bar{D}$ decay correlations in a judicious fashion.

29391 (SLAC–343, pp. 196-206) **Rare decays of D-mesons.** Willey, R.S. (Univ. of Pittsburgh, PA (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

A proposed Tau-charm factory could reach branching ratios (BR) for D-meson decays down the 10^{-7} level (see the rest of these proceedings). In this contribution the author gives the theoretical expectations for some rare decay modes. The modes considered are: (1) Lepton number violating decays e.g. $D^0 \to \mu^+e^-$. (2) Flavor changing neutral current (FCNC) semileptonic and radiative modes, $D \to \ell\bar{\ell}X$, $D \to \nu\bar{\nu}X$, $D \to \gamma X$. The discussion will be in 2 contexts: (i) the standard model (SM; in particular the minimal version with just three generations of fermions and one Higgs doublet.) (ii) anything beyond the minimal standard model (new physics).

29392 (SLAC–343, pp. 207-219) **J/ψ and charmonium physics in a tau charm factory.** Toki, W.H. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

A high luminosity Tau Charm Factory will yield a sample of 10^9 J/ψ and .5 x 10^9 ψ′ produced events per month of running. This represents an enormous increase over previous data samples. In this paper the physics of glueballs, charmonium decays, meson spectroscopy, and rare decays of the J/ψ and ψ′ that are possible with this data are discussed.

29393 (SLAC–343, pp. 231) **High statistics experiments: The LASS experience.** Awaji, N.; Fujii, K.; Hayashii, H.; Iwata, S.; Kajikawa, R.; Matsui, T.; Miyamoto, A.; Ozaki, H.; Pak, C.; Shimomura, T. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

This paper summarizes the main data processing and analysis procedures employed by the LASS collaboration in the course of a Kp experiment involving 138 million triggers at an incident momentum of 11 GeV/c. The role of multivertex kinematic fitting at the coordinate level is described, and the importance of the ~4 π acceptance for both large and small statistics exclusive channels is discussed. The evolution in understanding of the amplitude structure of mesonic states which has resulted from the acquisition and analysis of large data samples is illustrated using the Kπ S-wave and the partial wave decomposition of the low-mass Kππ system. Implications for future studies of sš spectroscopy at the KAON factory, and for amplitude analyses of meson systems produced in J/ψ decay at a Tau-Charm factory are considered.

29394 (SLAC–343, pp. 232-243) **A Tau-Charm factory in the United States.** Coward, D.H. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

As the conclusions of the many presentations made at the Tau-Charm Workshop illustrate, a strong case can be made for the physics program that can be accomplished at a Tau-Charm Facility. This idea is now being taken one step further. A group of physicists and engineers have started a serious effort to design a Tau-Charm Facility for the US. Their first choice would be to place the Facility at SLAC, but, since it would be built with its own injector and positron source, it could be built at any number of other suitable locations in the US. The people who worked hard on the concept (both from the accelerator physics and particle physics points-of-view) and the initial design leading up to the Workshop are given in the first reference.

29395 (SLAC–343, pp. 244-251) **τ-charm factory workshop machine physics summary.** Brown, K.L.; Fieguth, T.; Jowett, J.M. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

Designing a τ-charm Factory to meet the requirements of the experimentalists raises a number of challenging problems in accelerator physics. This was reflected in a set of particularly productive sessions in the Accelerator Physics Working Groups. The summary which follows is intended as a guide to help the reader find his way through the more detailed material reproduced in these proceedings. They have tried to list the participants after the headings summarizing the work of the accelerator physics subgroups but it should be borne in mind that the composition of the subgroups varied in time and there was a good deal of overlap among them.

29396 (SLAC–343, pp. 252-288) **Physics summary τ-Charm factory workshop.** Seiden, A. (Univ. of California, Santa Cruz (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The author will try to emphasize examples of the most important and unique physics topics for the τ-charm factory. The author will assume that a year of data-taking corresponds to an integrated luminosity of 10^{40} cm^{-2}. Detailed analysis of the signal rates and backgrounds has been done using a detector approximately similar to the one worked out at the workshop. Effects of resolution and particle decays are usually included in the simulation. More subtle sources of systematics have not yet been fully studied.

29397 (SLAC–343, pp. 289-293) **Triggers at a Tau/Charm factory.** Thaler, J.J. (Univ. of Illinois, Urbana (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

Data rates and pattern recognition are considered for a general purpose detector at a tau/charm factory operating at 10^{33} luminosity. The conclusion is that the primary concern must be to control the understanding of efficiencies and systematic errors at the 0.1% level. Data rates are manageable even at the highest luminosity.

29398 (SLAC–343, pp. 294-316) **Detector summary: τ-Charm factory workshop.** Kirkby, J. (CERN, Geneva (Switzerland)); Brau, J.E.; Lueth, V.; Sliwa, K.; Stroynowski, R.; Weinstein, A.; Thaler, J.; Ratcliff, B.N.; Va'vra, J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

During the Workshop the physics goals of the τ-charm Factory (τcF) were studied and their specific detector requirements evaluated. Based on these requirements and the constraints of the machine, the Detector Working Groups explored various approaches and arrived at a basic detector configuration, using existing technologies, that successfully meets the physics requirements. This configuration, which they summarize in this paper, involves a conceptual design with an initial specification of detector components, their locations and dimensions. No attempt was made at the Workshop to go into detailed aspects of the design or to optimize the materials, dimensions, granularities, etc; this next stage of the detector design is taking place over the coming months.

29399 (SLAC–343, pp. 317-329) **Design of a high luminosity collider for the Tau-Charm factory.** Oide, Katsunobu. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

Important relations between basic parameters of a high-luminosity collider are discussed. As the result, it is shown that the maximum bunch spacing is limited by the beam current to clear the threshold of the bunch lengthening. In order to solve the short bunch spacing, the crab-crossing scheme is applied to a design of the ring with 2.2 GeV, 2×10^{33} cm^{-2} s^{-1} luminosity.

29400 (SLAC–343, pp. 342-354) **Multibunch instability investigations for a Tau-Charm Factory.** Zisman, M.S. (Lawrence Berkeley Lab., CA (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. DOE Contract AC03-76SF00098. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

In the design of high-luminosity colliders for high-energy physics, it has become clear that multibunch instabilities will be one of the primary effects that limit beam intensity, and hence luminosity. This paper reports on a series of calculations of multibunch growth rates, using the LBL accelerator physics code ZAP, that illustrate the seriousness of the effect for typical design parameters of a Tau-Charm Factory.

29401 (SLAC–343, pp. 355-368) **Calculation of coupled-bunch instabilities in a Tau-Charm Factory.** Thompson, K.A. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

An essential consideration in the design of tau-charm factory storage rings is the control of coupled-bunch instabilities. In this paper, examples of calculations of the growth times of these instabilities are presented. With careful attention to the design of the RF and feedback systems, it should be feasible to control these instabilities and achieve the desired luminosity.

29402 (SLAC–343, pp. 369-377) **Status and limits of DORIS II.** Nesemann, H. (DESY, Hamburg (West Germany)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

DORIS first came into operation in 1973 as a double ring. Later on it was rebuilt as a single ring, and the maximum energy was increased from 3.5 GeV and to 5.6 GeV. The experience with the double ring is briefly described, and that with the single ring in more detail. Emphasis is put on those topics which are important for the design of the future storage ring colliders. DORIS II is also operating as a source for synchrotron radiation. But this aspect is not treated here.

29403 (SLAC–343, pp. 378-386) **A fast injection system with a superconducting accumulator ring for a Tau Charm Factory.** Barletta, W.A. (Univ. of California, Los Angeles (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. DOE Contract W-7405-ENG-48. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The type of high luminosity, storage ring collider being studied by SLAC for a tau-charm factory will require high energy, low emittance sources of positrons and electrons suitable for filling the rings. Ideally, the fill time should be much shorter than the luminosity life-time of the rings. For the purpose of estimating the characteristics of the injection system, the maximum fill time is taken to be O (100) seconds. The characteristics of the asymmetric storage rings have been studied by Jowett (1). In his parameter studies, Jowett has found that the luminosity life time should be O(10^4 sec). Similar studies conducted at SLAC prior to this workshop have resulted in a set of specifications to be met by the designers of the injection system.

29404 (SLAC–343, pp. 387-393) **Effects of charged Higgs in τ decay.** Tsai, Yungsu. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

An experiment to test the effect of charged Higgs exchange in τ decay is proposed. It is pointed out that in the decay $\tau^- \rightarrow \nu_\tau + \pi^- + \pi^0$ the effect due to Higgs exchange can be obtained by observing the angular distribution of the π^- in the rest frame of the $\pi^- + \pi^0$. For each value of invariant mass of the $\pi^- + \pi^0$ system, the π^- must have a unique p-wave angular distribution independent of the strong interaction if it is due to W^- exchange alone. Any s-wave interference with this p-wave angular distribution can be attributed to the scalar exchange.

29405 (SLAC–343, pp. 394-404) **Effects of W_R and charged Higgs in the leptonic decay of τ.** Tsai, Yungsu. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA),

23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

Experimental test of the existence of the right-hand W boson and the charged Higgs particle is suggested. The experiment involves measurement of muon polarization from the decay of polarized τ.

29406 (SLAC–343, pp. 405) **A heavy fourth family neutrino and the τ-lifetime discrepancy.** Shin, M. (Univ. of California, Irvine (USA)); Silverman, D. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

If there is a fourth generation, then the τ neutrino ν_τ will be a superposition of the mass eigenstates $\nu_\tau = U_{\tau 1}\nu_1 + U_{\tau 2}\nu_2 + U_{\tau 3}\nu_3 + U_{\tau 4}\nu_4$. It is possible that the fourth family neutrino is heavier than the τ itself, so that the τ cannot decay to this component of its wave function, resulting in a decrease in the decay probability or increase in the τ lifetime. This idea was proposed in references 1 and 2 where a more complete discussion can be found. The resulting decay rate to a single mode is $\Lambda(\tau^- \rightarrow e^- + \tilde{\nu}_e + \nu_\tau) = G_F{}^2 m_\tau{}^5/192\pi^3\ (1 - ||U_{\tau 4}||^2)$, $\Lambda(\tau^- \rightarrow e^- + \tilde{\nu}_e + \nu_\tau) = BR(\tau^- \rightarrow e^- + \tilde{\nu}_e + \nu_\tau)/\tau_\tau$. Scaling by the muon lifetime gives experimental numbers except for $||U_{\tau 4}||^2\ \tau_\tau/\tau_\mu\ (m_\tau/m_\mu)^5\ (1 - ||U_{\tau 4}||^2) = BR\ (\tau^- \rightarrow e^- + \tilde{\nu}_e + \nu_\tau)$. Using experimental values from K. Hayes (this workshop) gives $(18.92 \pm 0.49)\%(1 - ||U_{\tau 4}||^2) = (17.96 \pm 0.26)\%\ ||U_{\tau 4}||^2 = 0.051 \pm 0.028$. This is the same order as $\sin^2\theta_c$, and is a non-zero value at the 1.7σ level. More accurate measurements of the lifetime and branching ratios of the τ in a τ-charm factory would allow a study of a fourth generation mixing angle, if there is a fourth neutrino heavier than the τ lepton.

29407 (SLAC–343, pp. 406-407) **The τ anomalous magnetic moment measured from the angular dependence of the charged secondary.** Silverman, D. (Univ. of California, Irvine (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The authors examine the angular distributions of the charged secondaries from τ decays into two or three bodies and show that their angular distributions can be used to isolate the effect of an anomalous magnetic moment $F_2(q^2)$ of the τ when it couples to the virtual photon in e^+e^- annihilation. Here, $F_2(0) = a_\tau = (g - 2)/2$. The virtual photon momentum squared is $q^2 = E_{CM}{}^2 = 4E^2$, and $\beta = \sqrt{1 - 4m^2/q^2}$.

29408 (SLAC–343, pp. 436-443) **Backgrounds to τ studies below charm threshold.** Kirkby, J. (CERN, Geneva (Switzerland)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

Using DELCO data obtained at SPEAR, the authors evaluate the backgrounds to $\tau^+\tau^-$ data samples below open charm threshold at the τ-charm Factory (τcF). With a single-tagging signature (electron and missing energy, E_{miss}), which is unique to the τcF, the backgrounds are found to be below 0.1%.

29409 (SLAC–343, pp. 444-462) **Leptonic decays of the τ-lepton and the structure of the charged leptonic weak interaction.** Fetscher, W. (Institute for Intermediate Energy Physics, Villigen (Switzerland)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The Lorentz structure of leptonic τ decays cannot be determined by measuring the Michel parameter ρ precisely. It is known from muon decay, however, that the interaction can be fixed by measuring the life-time and four additional parameters yielding information about the lepton chiralities. Two of these, the asymmetry parameters ξ and δ, could be measured at the proposed Tau-Charm-Factory at a c.m. energy of 4 GeV. This would limit five of the ten complex coupling constants. In addition to a more precise measurement of ρ also the low energy spectrum parameter η_μ can be measured with good precision. Its measurement is needed for the test of the universality of the weak interaction.

29410 (SLAC–343, pp. 490-503) **Precision measurements of the τ lifetime.** Kass, R. (Ohio State Univ., Columbus (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. DOE Contract AC02-76ER01545. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

One of the cornerstones of the standard model of electroweak interactions is the universality of the charged coupling constant. For the case of the τ lepton e, μ, τ universality allows us to calculate the lifetime of the τ in terms of the μ mass and lifetime, τ mass and the branching ratio of τ into electrons or muons. Thus a measurement of the τ lifetime is of primary importance as it either affirms the standard model or provides evidence beyond the standard model. In this note they speculate on the opportunities for measuring the τ lifetime at various laboratories over the next few years.

29411 (SLAC–343, pp. 504-518) **τ physics with the TPC/2γ detector at PEP.** Marsiske, H. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The TPC/2γ detector and the PEP machine have been upgraded for high-luminosity running. The authors describe the performance of the new configuration during a test run in fall 1988. Prospects for progress in τphysics, based on a large data sample to be recorded by the TPC/2γ detector, are reviewed.

29412 (SLAC–343, pp. 519-527) **Tau decays to multiphoton final states.** Skwarnicki, T. (Syracuse Univ., NY (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

Present status and future prospects of measurements on τ decays to final states with π^0 and η are discussed.

29413 (SLAC–343, pp. 528-537) **Lepton flavor violation and rare tau decays.** Heusch, C.A. (Univ. of California, Santa Cruz (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The author points out that the good statistics promised by the proposed Tau-Charm Factory for tau lepton pair production close to threshold, in combination with the high purity of the tagged sample, opens a window onto new physics phenomena: lepton flavor violation involving the third family of basic fermions may have uniquely

interesting implications not accessible in interactions under scrutiny elsewhere.

29414 (SLAC–343, pp. 538-544) **Can the Higgs sector be probed in Tau-lepton decays?** Haber, H.E. (Univ. of California, Santa Cruz (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

It is unlikely that a high statistics study of τ-lepton decays will be sensitive to the Higgs boson sector of electroweak physics.

29415 (SLAC–343, pp. 545-553) **How to search for an electric dipole form factor of the τ lepton at a τ-charm factory.** Bernreuther, W. (Lawrence Berkeley Lab., CA (USA)); Nachtmann, O. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. DOE Contract AC03-76SF00098. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The authors investigate some CP-odd correlations which can be used to search for an electric dipole form factor $d_\tau(s)$ of the τ in the reaction $e^+e^- \rightarrow \tau^+\tau^-$ at c.m. energies $\sqrt{s}$ relevant for a τ-charm factory. These observables require measurement of the τ polarizations. Using the channel $e^+e^- \rightarrow \tau^+\tau^- \rightarrow \pi^+\bar{\nu}_\tau\pi^-\nu_\tau$ one should be able to measure d_τ at $\sqrt{s} = 4$ GeV with an accuracy $\delta(d_\tau) \simeq 2.5 \times 10^{-16}$e cm, assuming the production of 10^7 τ pairs. The same accuracy can be reached with 10^6 τ pairs at $\sqrt{s} = 10$ GeV, the typical c.m. energy of a B-factory.

29416 (SLAC–343, pp. 554-575) **Multiple-neutral-meson decays of the τ lepton and electromagnetic calorimeter requirements at tau-charm factory.** Gan, K.K. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

This is a study of the physics sensitivity to the multiple-neutral-meson decays of the τ lepton at the Tau-Charm Factory. The sensitivity is compared for a moderate and an ultimate electromagnetic calorimeter. With the high luminosity of the Tau-Charm Factory, a very large sample of the decays $\tau^- \rightarrow \pi^-2\pi^0\nu_\tau$ and $\tau^- \rightarrow \pi^-3\pi^0\nu_\tau$ can be collected with both detectors. However, with the ultimate detector, $2\pi^0$ and $3\pi^0$ can be unambiguously reconstructed with very little background. For the suppressed decay $\tau^- \rightarrow \pi^-\eta\pi^0\nu_\tau$, only the ultimate detector has the sensitivity. The ultimate detector is also sensitive to the more suppressed decay $\tau^- \rightarrow K^-\eta\nu_\tau$ and the moderate detector may have the sensitivity if the hadronic background is not significantly larger than that predicted by Lund. In the case of the highly suppressed second-class-current decay $\tau^- \rightarrow \pi^-\eta\nu_\tau$, only the ultimate detector has sensitivity. The sensitivity can be greatly enhanced with a small-angle photon veto.

29417 (SLAC–343, pp. 589-594) **Supersymmetry and τ decays.** Stroynowski, R. (California Institute of Technology, Pasadena (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

A brief review of the status of searches for supersymmetry involving the τ lepton is given.

29418 (SLAC–343, pp. 595-604) **The τ one-prong problem and recent measurements by the HRS collaboration.** Repond, J. (Argonne National Lab., IL (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The authors summarize recent measurements by the HRS collaboration of the topological branching fractions, the production cross section, the lifetime, and the rate into electrons of the τ lepton. An inconsistency with theoretical expectations persists at the level of two standard deviations.

29419 (SLAC–343, pp. 605-615) **Semileptonic charm decay at a tau charm factory.** Izen, J.M. (Univ. of Illinois, Champaign (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. DOE Contract AC02-76ER01195. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The full spectrum of $D_{\ell 3}$ and $D_{\ell 4}$ semileptonic decays can be precisely measured at a Tau Charm Factory. Sensitivity to rare semileptonic decays extends to branching fractions as small as 10^{-3}. Improved measurements of Cabibbo-Kobayashi-Maskawa matrix elements $V_{cs}$and V_{cd} can be obtained. With an improved theoretical understanding, semileptonic measurements can test the unitarity of the second row of the Cabibbo-Kobayashi-Maskawa matrix at the 1% level.

29420 (SLAC–343, pp. 616-629) **D_s^+ semileptonic decays at a τ-Charm Factory.** Pitman, D. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

Preliminary studies of semileptonic D_s^+ decays have been made. The analysis relies on a large sample ($\approx 10^6$) of tagged hadronic D_s^+ events. The Monte Carlo study involved specific decay channels, $D_s^+ \rightarrow \phi e^+\nu_e$ and $D_s^+ \rightarrow K^0e^+\nu_e$, at a center-of-mass energy of 4.03 GeV. Background events due to other D_s^+ modes and to D^0 and D^+ decays are examined. The possibility of signal reconstruction at a center-of-mass energy of 4.14 GeV is investigated.

29421 (SLAC–343, pp. 630-636) **V_{cd} and V_{cs} from current models.** Ward, B.F.L. (CERN, Geneva (Switzerland)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. DOE Contract AS05-76ER03956. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The authors discuss the theoretical uncertainties attendant to the determination of $|V_{cd}|/|V_{cs}|$ from semileptonic D decay. Four different theoretical approaches are considered. Currently, agreement at the level of a factor of 2 for the various theoretical approaches exists so that, indeed, precise experimental data - such as precise lepton energy spectra and decay width data - would discriminate among the models considered.

29422 (SLAC–343, pp. 637-643) **Leptonic and semileptonic d-decays from QCD sum rules.** Paver, N. (University of Trieste (Italy)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

Leptonic and semileptonic decay amplitudes play a key role for a determination of the KM quark mixing matrix as well as for a test of a wide variety of theoretical predictions on heavy flavor weak

transitions. Thus considerable effort has been devoted to the theoretical estimates of the leptonic constant f_D (and f_B) and of the Dl_3 (and Bl_3) decay form factors. Here the author briefly presents some results on these transitions, which have been obtained in the framework of QCD sum rules.

29423 (SLAC–343, pp. 644-661) **Unsolved problems in hadronic charm decay.** Browder, T.E. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

This paper describes several outstanding problems in the study of hadronic decays of charmed mesons where further experimental work and theoretical understanding is needed. Four topics are stressed: doubly Cabibbo suppressed decays (DCSD) of D^+ mesons, hadronic D_s decays, weak hadronic quasi-two-body decays to pairs of vector mesons, and penguin decays of D mesons.

29424 (SLAC–343, pp. 662-670) **Physics from doubly quark-mixing suppressed charm meson decays.** Chau, Linglie (Univ. of California, Davis (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

Interesting physics and predictions are discussed in the doubly quark-mixing matrix suppressed charm meson decays: into vector-pseudoscalar, pseudoscalar-pseudoscalar, vector-vector mesons.

29425 (SLAC–343, pp. 671-685) **Pure leptonic decays of the D and D_s mesons.** Kim, P.C. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

This report presents a feasibility study of the pure leptonic decays of charmed mesons at a Tau-Charm Factory. A year of running with a luminosity of 10^{33} cm^{-2} sec^{-1} would allow precise measurement of f_D and f_{D_s} at a percent level, providing a benchmark test of Lattice QCD calculations. Possible observation of mass-dependent couplings in D_s decays to $\tau\nu$ and $\mu\nu$ is also discussed.

29426 (SLAC–343, pp. 686-694) **Flavor changing neutral processes bounded by B_d^0 - $\bar{B}_d^0$ mixing and predictions for the Tau-Charm Factory.** Shin, M. (Univ. of California, Irvine (USA)); Bander, M.; Silverman, D. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

In our present understanding of particle physics, there is one potentially important piece of experimental data whose explanation may require new physics beyond the standard model. It is the surprisingly large B_d^0 - $\bar{B}_d^0$ mixing reported by the ARGUS collaboration, which has been confirmed by the CLEO collaboration. In this talk, the authors propose that this mixing is due to or is bound to tree-level flavor changing couplings of the standard model Higgs scalar, H^0, or the Z^0, induced by new physics beyond the standard model. A more complete treatment of this by these authors is in refs. 3 and 4. In sec. 2, they present an illustrative example, based on new heavy weak-isospin singlet heavy quarks, where physics beyond the standard model could be responsible for such flavor changing neutral current processes (FCNP) of the known quarks and leptons. In Sec. 3, they look at various theoretical expectations for the flavor dependence of these couplings. In Sec. 4, they assume that the large B_d^0 - $\bar{B}_d^0$ mixing is due to such FCNP and this anchors one of these couplings. They then analyze all relevant processes using the assumptions on the dependence of the couplings on quark or lepton masses from Sec. 3. The results are pleasing in that not only are the bounds not seriously violated, but several unseen reactions are on the verge of observability. In this talk they focus on those that are relevant for the τ-charm factory.

29427 (SLAC–343, pp. 695-705) **CP noninvariance: A charm possibility.** Chau, Linglie (Univ. of California, Davis (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

CP noninvariance in charm meson decays is discussed in comparison to that in the B and K mesons. It is pointed out that in the case of higher than three generations of quarks, CP nonvariance effects can be substantial in charm decays. It is also pointed out how inclusive semileptonic decays can be used to measure $D^0\bar{D}^0$ mixing and mass-matrix CP noninvariance.

29428 (SLAC–343, pp. 706-723) **Monte Carlo study of CP asymmetry measurement at a Tau-Charm Factory.** Karshon, U. (Stanford Univ., CA (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

It is shown that, for $D^0\bar{D}^0$ mixing of order $\sim$ 1%, it may be possible to observe in a Tau-Charm Factory a CP violation effect in the D^0 $\bar{D}^0$ system via a CP asymmetry. The method used is to tag one D by its semi-leptonic decay and to look for decays of the other D into CP eigenstates. It is estimated that within 1 year of running at the designed luminosity of L = 1033 cm^{-2} sec^{-1}, $\sim$ 6,600 such events can be collected.

29429 (SLAC–343, pp. 724-732) **A study of rare D decays for the Tau-Charm Factory.** Stockdale, I.E. (Univ. of Cincinnati, OH (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The authors present a study of the sensitivity to rare D decays of a Tau-Charm Factory detector. The authors consider both flavor changing neutral currents and family number violating decays, and evaluate the impact of varying the solid angle coverage, lepton identification and neutral hadron identification of the detector. They find that stringent demands must be made on the detector design in order to effectively use the expected data sets to observe small signals (branching fractions $\sim 10^{-7}$ - 10^{-8}) at a five standard deviation level of statistical significance.

29430 (SLAC–343, pp. 733-741) **Physics at the ψ(2S).** Burnett, T.H. (Univ. of Washington, Seattle (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The ψ(2S) hides some potentially interesting secrets that could be explored in only a day, given the high luminosity of the τcF, and the good acceptance of the proposed detector. The author will examine the puzzle of the suppressed hadronic decays to a vector and a pseudoscalar, the as yet unconfirmed h_{c1} and $\eta_c(2S)$ charmonium states, and speculation on the hadronic decays of the χ_{c0}, and examine J/ψ physics that could be done at the ψ'.

29431 (SLAC–343, pp. 742-748) **Open topics in charmonium physics.** Mir, R. (Univ. of Washington, Seattle (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The current status of the charmonium system is reviewed. Several interesting issues are discussed: the absolute branching ratio of $\Psi' \to \gamma\eta_c$ and $\Psi' \to \gamma\eta_c'$; the full width and the $\gamma\gamma$ width of the η_c and η_c'; the three photon decay of the Ψ; and hadronic decays of the η_c. Predictions for the rates of these processes at a future Tau Charm Factory are presented.

29432 (SLAC–343, pp. 749-762) **Tasks in η_c physics.** Heusch, C.A. (Univ. of California, Santa Cruz (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The design luminosity for the Tau/Charm Factory suggests the collection of 10^6 (10^7) events within one month (year), where the vector charmonium ground state decays radiatively to the pseudoscalar ground state. The authors point up physics possibilities that become accessible through these parameters.

29433 (SLAC–343, pp. 763-778) **Scalar and tensor meson spectroscopy at a τ-charm factory.** Bolton, T. (Columbia Univ., Irvington, NY (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

While the clear identification of a glueball would be universally accepted as a fundamental discovery, all such searches have thus far produced ambiguous results. Simplified analyses based on low statistics data samples collected with low acceptance detectors have possibly introduced as much confusion as understanding. However, there is a correct way to do spectroscopy, especially in the two pseudoscalar channel. Several ingredients are necessary: high statistics - $\sim$ 1,000 events per 25 MeV/c^2 mass bin- to make partial wave analyses statistically meaningful; high acceptance - $\gtrsim$ 95% of the 4π solid angle- so that spin analyses are not confused; a clean and well-understood production mechanism, to both aid the analysis and assist in the interpretation; the ability to simultaneously study as many final states as possible to allow cross checking of results and to assist in their interpretation. For the remainder of this report, it will be shown that each of these requirements can be met by building the appropriate detector at a τ-charm factory and adopting the right approach to analyzing the data.

29434 (SLAC–343, pp. 800-815) **The Iota in radiative J/ψ decays.** Burchell, M. (Univ. of California, Santa Cruz (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

Given the OZI suppression of strong J/ψ decays, the electromagnetic decays are equally accessible. Radiative J/ψ decays (see figure 1) offer a particularly clean environment for searches for light mesons. Several experiments (MarkII, Crystal Ball, DM2 and MarkIII) have accumulated large samples of J/ψ decays at rest and have searched for decay modes down to branching ratios of some 10^{-4}. Clean. strong signals are seen for many mesons of interest. One of the glueball candidate states that has emerged in the last 10 years or so is the iota (mass around 1,440 MeV/c^2, width 40 → 80 MeV/c^2). This is seen very well in radiative J/ψ decays in the KKπ final state. Below the authors reviews the reported observations of this state, then, using MarkIII data, he discusses the current status of their studies of the iota and also point to future directions for such work at a high statistics (10^9 J/ψ/month) τ-charm factory.

29435 (SLAC–343, pp. 816-828) **Production of $Q^2\bar{Q}^2$ states.** Li, Bingan. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

In this talk, the productions of $Q^2\bar{Q}^2$ states in two-photon collision and J/ψ radiative decays are discussed.

29436 (SLAC–343, pp. 829-835) **Scalar meson spectroscopy in hadronic J/ψ decays at a τ-charm factory.** Lockman, W.S. (Santa Cruz Institute for Particle Physics, CA (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The low-multiplicity vector-P$\bar{P}$ final states are inherently straightforward to analyze and are nearly background-free. Excellent π-K-p separation can be achieved using current-technology time-of-flight and dE/dX systems, together with kinematic fitting, due to the relatively low momenta involved (0.3-1.0 GeV/c). The particle identification requirements are even less severe here than in the corresponding radiative decays, because the vector mesons are massive. In most regions of P$\bar{P}$ mass, present analyses are handicapped by limited statistics and incomplete tracking, calorimetric and particle identification solid-angle coverage. The author reviews the present knowledge of nonradiative 0^{++} isoscalar production into the P$\bar{P}$ final state, and indicate how a τ-Charm Factory experiment will help to solve some of the outstanding experimental questions. The radiative decays are presented by T. Bolton at this conference.

29437 (SLAC–343, pp. 836-845) **Coupled channel interactions in J/ψ → V[PP]S-wave.** Weinstein, J. (Univ. of Tennessee, Knoxville (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The author review the model which lead us to the concept of the K$\bar{K}$ Molecule and show how it can be extended to apply to S-wave pseudoscalar-pseudoscalar production spectra such as those seen in J/ψ → V[PP]S-wave. The author presents some preliminary results of this analysis.

29438 (SLAC–343, pp. 846-872) **Strangeonium spectroscopy at the J/ψ: A comparison with kaon hadroproduction.** Ratcliff, B.N. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144–: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

An experimental program to study strangeonium mesons produced in the decays of the J/ψ at a τ-charm factory is compared with experiments on similar final states in kaon hadroproduction. The sample sizes and experimental performance required are discussed. The complementarity of different production modes and the importance of a broad programmatic approach to this physics are stressed.

29439 (SLAC–343, pp. 873-908) **Tests of quantum chromodynamics in exclusive e^+e^- and $\gamma\gamma$ processes.** Brodsky, S.J.

Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144--: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

Few-body exclusive reactions initiated by electromagnetic initial states is one of the most important areas of investigation in quantum chromodynamics. This report discusses electron-positron and two-photon processes. Factorization theorem for exclusive processes is presented. Other topics in this report include; electromagnetic form factors of baryons, suppression of final state interactions, the gamma-pi_0 transition form factor, exclusive charmonium decays, the π-ρ puzzle, time-like compton processes, multi-hadron production, heavy quark exclusive states and form factor zeros in QCD, exclusive gamma-gamma reactions, higher twist effects, and tauonium and threshold tau^+tau^- production.

29440 (SLAC–343, pp. 911-929) **Central tracking design for a τ-charm factory.** Weinstein, A.J. (California Institute of Technology, Pasadena (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144--: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The authors discuss the considerations involved in the design of a central tracking system for a τ-Charm Factory, including the required momentum resolution, angular coverage, material contributing to multiple scattering, and a variety of other issues. These ideas were discussed during meetings of the Tracking Working Group at the τ-Charm Factory Workshop at the Stanford Linear Accelerator Center in May, 1989.

29441 (SLAC–343, pp. 930-939) **Particle identification using dE/dx technique.** Va'vra, J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144--: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

The author has calculated the dE/dx particle identification prediction for two cases, one assuming that the central drift chamber has 60 samples 1 cm long operating at 1 atm gas pressure, and the other assuming a special dedicated dE/dx module with only 20 samples 1 cm long and a dedicated dE/dx gas. The attempt was to compare standard gases with helium based gases. To calculate this problem one needs to determine two quantities. First, the most probable energy loss (as a function of particle velocity, gas and the detector parameters), and second, the energy loss fluctuations as a function of similar parameters. The knowledge of these two quantities allows one to calculate the two particle separation in terms of a number of sigmas as a function of momentum.

29442 (SLAC–343, pp. 940-955) **Design considerations for a Cerenkov Ring Imaging detector at the Tau-Charm factory.** Ratcliff, B.N. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144--: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

A schematic design of a Cerenkov ring imaging detector for use at a τ-charm factory is described. The performance of this device and its implications for the other parts of the spectrometer are discussed.

29443 (SLAC–343, pp. 956-962) **Time of flight technique.** Stroynowski, R. (California Institute of Technology, Pasadena (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. (CONF-8905144--: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

At first glance, the traditional Time of Flight (TOF) technique for identification of pions, kaons and protons seems to be ideally suited for the momentum range of particles produced at the Tau-Charm Factory. In the decays of τ leptons and charmed mesons most of the secondaries have momentum smaller than 1 GeV/c. The exception are the two- and three-body decays of ψ and ψ' where the region of interest extends to about 1.5 GeV/c. In the upper end of this momentum range the geometry of the detector will impose strict requirement on the necessary timing resolution.

29444 (SLAC–343, pp. 963-966) **τ-charm factory (τCF) data acquisition and offline requirements.** Sliwa, K. (Tufts Univ., Medford, MA (USA)). Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jun 1989. DOE Contract AC02-83ER40085. (CONF-8905144--: Tau-Charm Factory workshop, Stanford, CA (USA), 23-27 May 1989). In *Proceedings of the tau-charm factory workshop. Study of tau, charm and J/ψ physics; development of high luminosity e^+e^- rings; design of e^+e^- detectors for tau-charm physics.* Order Number DE90001785. Available from NTIS, PC A99/MF A01.

A single most important factor one has to consider while designing an offline reconstruction system, and similarly in the case of an on-line trigger, is its bandwidth. A priori, if there were no limitations to the number of bytes of data that one can push to (and from) the computer CPUs, one could - by multiplying the number of processors - reduce the clock processing time to an (almost) arbitrarily small value. In general, if a Data Acquisition (DAQ) System is capable of pushing N events per second across a bus while utilizing a fraction F of its bandwidth, one can process in an offline system based on the same single bus (and assuming the size of an output event equal to the size of an input one) M { <=} N/(2*F) events per second. A number of parallel computers (nodes) required in such a system is K = M*t, t being reconstruction time per event in the node used. To go beyond M, one has to multiply the number of complete systems (buses). It is no longer difficult to provide sufficient CPU power to reconstruct the data fast. The τ-Charm Factory should benefit from the experience of several large experiments presently underway - CDF, LEP experiments, D0, high rate fixed target at FNAL, CEBAF - in designing its offline structure and programming environment in a much more user friendly way than it has been done in the past. The author considers this the biggest challenge facing the τCF Offline Group. Many of the answers to those organizational questions may become known within the next few years, hopefully in time for the τCF to benefit from them.

6451 Particle Interactions and Properties - Experimental

Refer also to citation(s) 29387, 29389, 29393, 29410, 29411, 29412, 29417, 29418, 29423, 29427, 29431, 29434, 29438, 29514, 29515, 29532

29445 (BNL–44429) **V^0 production with 14.5 GeV/c silicon beams.** Bonner, B.E.; Buchanan, J.A.; Chiou, C.N.; Clement, J.M.; Corcoran, M.D.; Kruk, J.W.; Miettinen, H.E.; Mutchler, G.S.; Nessi, M.; Nessi-Tedaldi, F. Brookhaven National Lab., Upton, NY (USA); City Coll., New York, NY (USA); Johns Hopkins Univ., Baltimore, MD (USA); Rice Univ., Houston, TX (USA). 26 Mar 1990. 18p. Sponsored by City University of New York; U.S. DOE Energy Research. DOE Contract AC02-76CH00016;AC02-83ER40107;AS05-81ER40032;AC02- (CONF-900331–3: Heavy ion physics at the alternating gradient synchrotron, Upton, NY (USA), 5-7 Mar 1990). Order Number DE90010014. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This talk deals with Λ, K_s^0 and $\bar{\Lambda}$ production with 14.5 GeV/c Silicon beams. Why study Λ^0 production? Because the study of strangeness is an important part of the search for Quark Gluon Plasma (QGP). Many models predict an enhancement of strangeness in a QGP as compared to the amount of strangeness produced in a superposition of nucleon-nucleon interactions. The

amount of enhancement varies from model to model. Even if no QGP is detected at AGS energies using Si beams, it is important to understand the production mechanisms in quantitative detail so that standard nucleon-nucleon production mechanism can be distinguished from QGP formation. The advantage of measuring strangeness production by measuring V^0 production is that V^0's can be identified by kinematics without the use of any special particle ID detectors. The disadvantage is that usually large aperture detectors are required. Experiment 810 has the needed large aperture. This talk describes the technique and results of V^0 production from ~9000 interactions of Si in a 1 mil (25 micron) Au target recorded in June 1989. 13 figs., 1 tab.

29446 (KEK–89-7) **Proceedings of workshop on K-decay experiments.** Nakai, Kozi (ed.). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1989. 246p. (In Japanese). (CONF-8907188–: Workshop on K-decay experiments, Tsukuba (Japan), 11-12 Jul 1989). Order Number DE90777890. Available from NTIS (US Sales Only), PC A11/MF A01.

The elementary particle experiment using the 12 GeV proton synchrotron in the National Laboratory for High Energy Physics (KEK) develops centering around the large scale experiment on K-meson decay. In this case, the ideal precision physics is pursued, and efforts have been exerted to improve the experimental techniques. At present the experiment on searching for rare K-decay is advancing. Next, the experiment on searching for CP nonconservation process will be begun. However, these experiments are in severe competition with those in BNL and Fermilab which have powerful accelerators, therefore it is desirable to grasp well the development of the international research plans. Therefore, in order to obtain the quideline for the experimental plan using the KEK proton synchrotron hereafter, the workshop on K-decay was held on July 11≈12, 1989. In this workshop, Arisaka (UCLA), Numao (TRIUMF) and Yamanaka (Fermilab) returned from USA and lectured on the present status of the experiment and the future perspective. The impression of the planner of the proton synchrotron experiment plan on the experiments are recorded. (K.I.).

29447 (KEK–89-17) **Proceedings of the workshop on asymmetric B factory at KEK.** Yoshimura, Y. (ed.). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Nov 1989. 269p. (In Japanese). (CONF-8910393–: Workshop for asymmetric B-factory at KEK, Tsukuba (Japan), 2-4 Oct 1989). Order Number DE90777869. Available from NTIS (US Sales Only), PC A12/MF A01.

This issue is the collection of the papers presented at the title workshop. The 16 of the presented papers are indexed individually. (J.P.N.).

29448 (RCNP-P–106, pp. 69-73) **Search for narrow dibaryon.** Horikawa, Naoaki (Nagoya Univ. (Japan). Faculty of Science). Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

Published in summary form only. DIBARYONS/research programs; DIBARYONS; PARTICLE WIDTHS; REST MASS; PROTON REACTIONS; POLARIZED BEAMS; POLARIZATION-ASYMMETRY RATIO; HELIUM 3 TARGET; DEUTERONS; KEK SYNCHROTRON; POLARIZED TARGETS

29449 (UIUC-HEPG–90-56) **Hadroproduction of $D_s^+ \rightarrow (K\pi)\pi$.** Kroc, T.K. Illinois Univ., Urbana, IL (USA). Dept. of Physics. 1989. 152p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER01195. Order Number DE90009954. Available from NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.

A study of the decay $D_s^+ \rightarrow (K^- \pi^+)\pi^+$ (and charge conjugate) has been performed based on data taken from n-nucleus collisions by the experiment E400 at the Proton East area of FNAL. A signal was observed at the 3.3σ level that behaves properly under lifetime cuts. A method for determining the acceptance due to spectrometer geometry and analysis cuts was developed with the intention of making the acceptance as independent as possible of biases resulting from the production model chosen for the Monte Carlo studies that determined the acceptance. The acceptance was parameterized in two different ways chosen so that inconsistencies would expose any remaining model dependence. The cross-sections resulting from these two parameterizations were consistent and the average of the two is $\Delta\sigma$. Br = 2.36 ± .72 (statistical) ± 1.18 (systematic) over the range $-.02 < x_F < .3$. A comparison is made between this cross-section and the cross-section found for the decay $D_s \rightarrow (K^+ K^-)\pi$, also measured by E400 over the more limited range $0. < x_F < .14$ and the two values are found to be statistically consistent. The cross-section from $D_s \rightarrow (K\pi)\pi$ is compared to cross-sections determined by LERC, an experiment also using a hadron beam of energy similar to E400, with considerable disagreement although no explicit explanation is readily available. Both experiments, as well as many others, measure cross-sections that are considerably larger than lowest order QCD calculations. 41 refs.

29450 (UWThPh–1989-44) **Intermittency in multihadron production: An analysis using stochastic theories.** Biyajima, M. (Shinshu Univ., Matsumoto, Nagano (Japan). Dept. of Physics. Faculty of Liberal Arts); Bartl, A.; Mizoguchi, T.; Suzuki, N. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 12p. Order Number DE90623761. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Multiplicity data of the NA22, KLM, and UA1 collaborations are analysed by means of probability distributions derived in the framework of pure birth stochastic equations. The intermittent behaviour of the KLM and UA1 data is well reproduced by the theory. A comparison with the negative binomial distribution is also made. 19 refs., 3 figs., 1 tab. (Authors).

29451 Improved limit on the branching ratio of $K^+ \rightarrow \pi^+ \mu^+ e^-$. Lee, A.M.; Alliegro, C.; Campagnari, C.; Chaloupka, V.; Cooper, P.S.; Egger, J.; Gordon, H.A.; Hadley, N.J.; Herold, W.D.; Jagel, E.A. *Physical Review Letters (USA),* 64(2): 165-168 (8 Jan 1990). DOE Contract AC02-76CH00016;AC02-76ER03075.

A search for the lepton-flavor number-violating decay $K^+ \rightarrow \pi^+ \mu^+ e^-$ has been conducted at the Brookhaven Alternating Gradient Synchrotron. No candidates have been found which would be consistent with this decay mode. An upper limit on the branching ratio is placed at 2.6×10^{-10}, which can be combined with our previous result to yield an upper limit of 2.1×10^{-10} at the 90% confidence level. A limit on the branching ratio for $\pi^0 \rightarrow \mu^+ e^-$ of 1.6×10^{-8} (90% C.L.) is also established.

29452 Investigation of the electromagnetic structure of η and η' mesons by two-photon interactions. Aihara, H.; Alston-Garnjost, M.; Avery, R.E.; Barbaro-Galtieri, A.; Barker, A.R.; Barnett, B.A.; Bauer, D.A.; Bay, A.; Bobbink, G.J.; Buchanan, C.D. TPC/Two-Gamma Collaboration. *Physical Review Letters (USA),* 64(2): 172-175 (8 Jan 1990).

The TPC/Two-Gamma facility at the SLAC e^+e^- storage ring PEP was used to study the reactions $\gamma\gamma^* \rightarrow \eta$ and $\gamma\gamma^* \rightarrow \eta'$. The $\eta\gamma^*\gamma$ and $\eta'\gamma^*\gamma$ transition form factors were measured as functions of Q^2, the negative of the invariant mass squared of the tagged photon, in the range $0.1 < Q^2 < 7$ GeV^2. These determinations of the electromagnetic structure of the η and η' mesons are consistent with both vector-meson dominance and QCD. They also provide new measurements of the pseudoscalar mixing angle and decay constants.

29453 Results on hadronic decays of D and D_s mesons from Mark III. Kim, P.C. (Stanford Linear Accelerator Center, Stanford University, Stanford, CA (US)). Mark III Collaboration. *AIP Conference Proceedings (American Institute of Physics) (USA),* 196(1): 203-209 (15 Dec 1989). DOE Contract AM03-76SF00010;AC02-76ER01195;AC03-81ER40050;AC02-(CONF-8906204–: International symposium on heavy quark physics, Ithaca, NY (USA), 13-17 Jun 1989).

Recent results on hadronic weak decays of the charmed mesons, $D^0 \rightarrow \bar{K}^0\pi^0$, $\bar{K}^0\eta$, $\bar{K}^0\eta'$ and $D_s^+ \rightarrow \eta\pi^+$, $\eta'\pi^+$, from the Mark III at SPEAR are presented.

29454 Status of the top quark search at CDF. Foster, G.W. CDF Collaboration. *AIP Conference Proceedings (American Institute of Physics) (USA),* 196(1): 354-366 (15 Dec 1989).

(CONF-8906204–: International symposium on heavy quark physics, Ithaca, NY (USA), 13-17 Jun 1989).

A search for new heavy quarks is proton-antiproton collisions at the Fermilab Tevatron Collider ($\sqrt{s}$=1.8 TeV) is described. Primary emphasis is given to the search for final states in which the charged-current decays of a $t\bar{t}$ pair produce both an electron and a muon. The data taken during the first portion (2.0 pb^{-1}) of the 1988–1989 run is analysed. The top quark (as well as a fourth generation b' quark) is excluded at the 95% C. L. in the mass range 30 to 60 GeV/c^2. Other prospects for heavy quark physics at CDF are discussed.

29455 Predictions for CP violation. Gilman, F.J. (Stanford Linear Accelerator Center, Stanford University, Stanford, CA 94309 (US)). *AIP Conference Proceedings (American Institute of Physics) (USA)*, 196(1): 367-384 (15 Dec 1989). DOE Contract AC03-76SF00515. (CONF-8906204–: International symposium on heavy quark physics, Ithaca, NY (USA), 13-17 Jun 1989).

Predictions for CP violation in the three-generation Standard Model are reviewed, especially as they pertain to the K and B meson systems.

29456 Two-photon production of the η_c. Jensen, T. (The Ohio State University, Columbus, OH 43210 (US)). *AIP Conference Proceedings (American Institute of Physics) (USA)*, 196(1): 325-330 (15 Dec 1989). DOE Contract AC02-76ER01545. (CONF-8906204–: International symposium on heavy quark physics, Ithaca, NY (USA), 13-17 Jun 1989).

A brief review of two-photon production of the η_c is given. Preliminary results from the CLEO experiment are presented and shown to be in good agreement with theoretical predictions.

29457 Study of Ψ' decays. Toki, W.H. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94309 (US)). Mark III Collaboration. *AIP Conference Proceedings (American Institute of Physics) (USA)*, 196(1): 317-324 (15 Dec 1989). DOE Contract AM03-76SF00326;AC02-76ER01195;AC03-81ER40050;AC02- (CONF-8906204–: International symposium on heavy quark physics, Ithaca, NY (USA), 13-17 Jun 1989).

Hadronic decays of the Ψ' are reviewed and a new preliminary upper limit of $B(\Psi' \to \rho\pi) < 7.0 \times 10^{-5}$ at 90% C.L. from the Mark III is presented.

6452 Particle Interactions and Properties - Theoretical

Refer also to citation(s) 29388, 29389, 29390, 29391, 29392, 29404, 29405, 29406, 29407, 29408, 29409, 29410, 29413, 29414, 29415, 29416, 29419, 29420, 29421, 29422, 29423, 29424, 29425, 29426, 29427, 29428, 29429, 29430, 29431, 29432, 29433, 29434, 29435, 29436, 29437, 29438, 29439, 29441, 29450, 29497, 29520, 29548, 29563

29458 (CEA-CONF–9578) **Topological objects in hadron physics.** Rho, M. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique. 1988. 20p. (CONF-8805140–: International conference on medium- and high-energy nuclear physics, Taipei (Taiwan), 23-27 May 1988). Order Number DE90770197. Available from NTIS (US Sales Only), PC A03/MF A01.

The notion of topological objects in hadronic physics is discussed, with emphasis on the role of the Wess-Zumino term and induced transmutation of quantum numbers in chiral bag models. Some applications to nuclear systems are given.

29459 (FNAL/C–90/43-T) **Report of the Electroweak Interactions Theoretical Issues Working Group.** Golden, M. Fermi National Accelerator Lab., Batavia, IL (USA). Nov 1989. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-890872–11: Workshop on physics at Fermilab in the 1990's, Breckenridge, CO (USA), 15-24 Aug 1989). Order Number DE90009573. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An interesting component of the physics program at Fermilab during the next ten years will be the precision verification of the standard model, rather than its extension. While there is a window for finding Z' gauge bosons, it is unlikely that it is possible to discover the standard model Higgs boson. Measurements of $W + \gamma$ rates can place limits on non-standard gauge boson couplings. QCD will be further tested by observation of W or Z plus multiple jets, a signal which is also interesting as a background to new particle searches. Precision measurements of the W and Z masses and the forward-backward asymmetry in Z decays can put limits on new physics. 26 refs., 1 fig., 2 tabs.

29460 (FNAL/C–90/57-T) **Minimal dynamical symmetry breaking of the electroweak interactions and m_{top}.** Hill, C.T. Fermi National Accelerator Lab., Batavia, IL (USA). Mar 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-900135–1: General meeting of the Division of Particles and Fields of the American Physical Society, Houston, TX (USA), 3-6 Jan 1990). Order Number DE90009574. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We review the recent idea of a mechanism for breaking the electroweak interactions which relies upon the formation of condensates involving the conventional quarks and leptons. In particular, such a scheme would indicate that the top quark is heavy, greater than or of order 200 GeV, and gives further predictions for the Higgs boson mass. It may be imbedded either into a GUT setting using supersymmetry or applied to a fourth generation with new strong TEV scale flavor-interactions. 13 refs., 2 tabs.

29461 (HEPHY/PUB–527) **Phenomenological aspects of nonrelativistic potential models.** Lucha, W. (Oesterreichische Akademie der Wissenschaften, Vienna (Austria). Inst. fuer Hochenergiephysik); Schoeberl, F.F. Oesterreichische Akademie der Wissenschaften, Vienna (Austria). Inst. fuer Hochenergiephysik. 1989. 45p. (UWThPh–1989-71). Order Number DE90623708. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

This review reports on the description of hardrons as bound states of quarks by nonrelativistic potential models. It contains a brief sketch of the way in which information on the form of the inter-quark potential may be gained from quantum chromodynamics, proofs of some general theorems related to the potential-model approach, a discussion of the significance of the treatment of bound states consisting of relativistically-moving constituents by the nonrelativistic Schroedinger formalism, as well as a brief survey of the motivations for the various proposed potential models. Finally, it illustrates the application of the developed theoretical framework at a few selected examples. 60 refs., 8 figs., 17 tabs. (Authors).

29462 (INS–785) **Deeply bound pionic states.** Yamazaki, Toshimitsu. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Nov 1989. 9p. Order Number DE90777709. Available from NTIS (US Sales Only), PC A02/MF A01.

We discuss the structure and formation of deeply bound π^- states in heavy nuclei, which are expected to be narrow due to the repulsive π^--nucleus interaction. Possible experiments to produce those states are described. (author).

29463 (INS–789) **Triplicity of hadrons, quarks and subquarks.** Terazawa, Hidezumi. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Nov 1989. 14p. Order Number DE90777712. Available from NTIS (US Sales Only), PC A03/MF A01.

Triplicity of hadrons, quarks and subquarks asserting that a certain physical quantity such as the weak current is taken equally well as either one of a composite operator of hadrons, that of quarks and that of subquarks is proposed. Among other things, the weak mixing angle, the quark mixing matrix and the mass sum rules for quarks and leptons are revisited, reinterpreted and discussed in detail in triplicity. (author).

29464 (INS–791) **Effects of exotic composite bosons in the TRISTAN, SLC and LEP region.** Akama, Keiichi (Saitama Medical Coll., Moroyama (Japan). Dept. of Physics); Hattori, Takashi; Yasue, Masaki. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Nov 1989. 17p. Order Number DE90777713. Available from NTIS (US Sales Only), PC A03/MF A01.

Starting with typical dynamical composite models for exotic bosons as well as weak bosons, we derive their effective interactions, examine the restrictions from the presently known

experimental results, and estimate possible effects on e^+e^- scattering. Some of the neutral exotics in the composite model, which decouple from neutrinos at low energies, can be as light as the order of the weak boson masses and offer the possibility of detecting sizable effects in the TRISTAN, SLC and LEP energy region. (author).

29465 (INS–796) **Studies of deeply bound pionic states by (d, ^{2}He) pion-transfer reactions at SATURNE.** Yamazaki, T. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Nov 1989. 10p. Order Number DE90777715. Available from NTIS (US Sales Only), PC A02/MF A01.

We propose to search for deeply bound π^- states in heavy nuclei by high resolution spectroscopy using (d, ^{2}He) reactions on heavy targets such as ^{208}Pb. Recent calculation by Toki and Yamazaki shows that even in ^{208}Pb the deeply bound pionic states (1s, 2p, etc.) are expected to have narrow widths due to the repulsive nature of the pion-nucleus interaction. To populate those states they proposed to use 'pion transfer' reactions such as (n, pπ^-). The experiment proposed here is to measure the (d, ^{2}He) spectrum around 140 MeV excitation, which lies in a valley between the nuclear GT and the Δ excitation regions. (author).

29466 (Juel-Spez–526) **Pion-pion and pion-kaon interaction in the meson exchange picture.** Lohse, D. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Kernphysik. Oct 1989. B78 (In German). Order Number DE90780369. Available from NTIS (US Sales Only), PC A05/MF A01.

Following the general line of the Bonn NN-interaction, a model for pseudoscalar-pseudoscalar meson interaction has been constructed and applied consistently to $\pi\pi$ and Kπ scattering. The phases can be reproduced with vector meson t- and s-channel exchange up to 1 GeV. The bare masses of the vector mesons turn out to be in the range of 1.1 GeV, depending on the form factor. We use a coupled channel formalism, which is crucial to explain the S* (975) resonance as a bound anti KK state. Beyond 1 GeV the data require a pseudoscalar-pseudoscalar coupling to a scalar octet (J^P=0$^+$) to fit the s-wave phases in the isospin-0 π and isospin-1/2 Kπ channels. We apply both scalar coupling and derivative coupling. The latter avoids introducing additional degrees of freedom and produces an acceptable fit to the J=0 phase shift data. (orig.).

29467 (Juel-Spez–527) **Antikaon-nucleon interaction in the meson exchange picture.** Mueller-Groeling, A. Kernforschungsanlage Juelich GmbH (Germany, F.R.). Inst. fuer Kernphysik. Oct 1989. 149p. (In German). Order Number DE90780368. Available from NTIS (US Sales Only), PC A07/MF A01.

Within the meson exchange framework of the Bonn NN-potential a model for the anti KN interaction near threshold is constructed. Employing a coupled-channels formalism we calculate total cross sections for six particle channels (pK$^-$, nanti K^0, $\Lambda\pi^0$, $\Sigma^0\pi^0$, $\Sigma^+\pi^-$, $\Sigma^-\pi^+$) and the Λ(1405) mass spectrum. The close connection between KN and anti KN diagrams due to G-parity conservation is exploited in order to examine the nature of short-range repulsion in the KN system. Our investigation suggests that this repulsion is not entirely due to ω-exchange but in addition consists of so far unknown processes of mixed G-parity. Furthermore, fourth-order contributions to the anti KN potential are shown to provide an important isospin dependent part of the interaction while Coulomb corrections turn out to be small, but not totally negligible. Our model definitely predicts Λ(1405) to be a anti KN quasibound state. The observed mass spectrum is reproduced without the inclusion of a genuine three quark state. Therefore we consider Λ(1670) to be the first excited 1/2$^-$ state of the uds-system and include corresponding pole graphs in our model. (orig.).

29468 (KEK–89-13, pp. 63-73) **Origin of CP violation.** Yamaguchi, Yoshio (Tokai Univ., Hiratsuka, Kanagawa (Japan). Faculty of Science). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Oct 1989. (In Japanese). (CONF-8903201–: 2. KEK symposium on ultracold neutrons (UCN) and fundamental physics with slow neutrons, Tsukuba (Japan), 11 Mar 1989). In *The 2nd KEK symposium on ultracold neutrons (UCN) and fundamental physics with slow neutrons.* Order Number DE90760025. Available from NTIS (US Sales Only), PC A07/MF A01.

The 2π decays of the K_L-meson, a unique and clear-cut evidence for CP violation, demonstrate an existence of C conserving but P violating and CP violating interaction $H_X{}^C$. This new interaction $H_X{}^C$ is flavor conserving and its effective strength is $\approx 10^{-3}$ of that of strong interaction. Implication of $H_X{}^C$ in particle and nuclear physics and nature of the spinless force carrier of $H_X{}^C$ are briefly described. (author).

29469 (MPI-PAE/Exp.El.–196) **Uncertainties in τ polarization measurement at SCL/LEP and QED/electroweak radiative corrections.** Boillot, F. (Ecole Polytechnique, 91 - Palaiseau (France). Lab. de Physique Nucleaire et des Hautes Energies); Was, Z. Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik. Nov 1988. 31p. Contract CPBP 01.09. Order Number DE90780364. Available from NTIS (US Sales Only), PC A03/MF A01.

We discuss the τ polarization measurement at SLC/LEP energies as a data point in the precision tests of the Glashow-Salam-Weinberg model. Theoretical and experimental uncertainties of this measurement are examined and it is concluded that apart from left-right asymmetry measurement, and for typical values of the parameters of the Standard Model, the τ polarization offers the best probe of the couplings of leptons to the Z^0. In particular, the dependence of the τ polarization on the top and Higgs masses is discussed. The interplay of QED initial state bremsstrahlung and other classes of radiative corrections is also discussed. (orig.).

29470 (NBI-HE–89-57) **Electroweak magnetism: Theory and applications.** Ambjoern, J.; Olesen, P. Niels Bohr Inst., Copenhagen (Denmark). Dec 1989. 34p. Order Number DE90623688. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The classical electroweak theory is unstable for magnetic fields H satisfying $eH > m_w{}^2$, m_w being the W mass. We discuss the origin of this instability and the peculiar anti-screening property of the W-condensate formed. The anti-screening is closely related to the asymptotic freedom of the $SU(2)_w$-fields. Assuming that the Higgs mass $m_h > m_w$ there will be a restoration of $SU(2)_w \times U_y(1)$ symmetry for $eH > m_h{}^2$. By using Bogomol'nyi's method in the special case where the mass of the Z-particle $m_z = m_h$ we can find static magnetic solutions with a vacuum condensate of W- and Z-bosons. This class of non-perturbative solutions interpolate between the constant magnetic field in the broken phase ($eH < m_w{}^2$) and a constant $U_y(1)$ field in the symmetric phase ($eH > m_h{}^2$). The consequences of this magnetic instability are discussed in the cases of superconducting cosmic strings, high temperatures (the early universe) and high energy collisions. (orig.).

29471 (NIKHEF-H–89-5) **Bottonium production at LEP.** Abraham, K.J. (Nationaal Inst. voor Kernfysica en Hoge-Energiefysica (NIKHEF), Amsterdam (Netherlands). Sectie H). Nationaal Inst. voor Kernfysica en Hoge-Energiefysica (NIKHEF), Amsterdam (Netherlands). Sectie H. Mar 1989. 8p. Order Number DE90623689. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The production of γ ($^3S_1$) and $\eta_b(^1S_0)$ with two gluons from Z decay is investigated. It is found that at LEP luminosities experimental detection will hardly be feasible. (author). 9 refs.; 1 fig.

29472 (RCNP-P–106, pp. 105-108) **Relativistic effects on electromagnetic interaction of deuteron.** Tamura, K. (Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics); Niwa, T. Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

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29473 (RRK–89-33) **Role of exotic mesons in nonleptonic weak decays of strange and charm mesons.** Terasaki, K.; Oneda, S. Hiroshima Univ., Takehara (Japan). Research Inst. for

Theoretical Physics. Dec 1989. 26p. Order Number DE90777765. Available from NTIS (US Sales Only), PC A03/MF A01.

Typical nonleptonic weak decays of strange and charm mesons are studied from the approach in which dynamical features of hadrons are dealt with in earnest. The amplitudes are always cast into the form $M \simeq M_{ETC} + M_S$ by using a hard PS-meson extrapolation. M_S, which can then be regarded as the Born term, is described by the sum of pole amplitudes involving the contributions from not only the ordinary {QQ-bar} but also the exotic [QQ][Q-barQ-bar] and (QQ)(Q-barQ-bar) mesons and a glue-ball. In particular, the persistent puzzle of the ratio, $\Gamma(D^0 \rightarrow K^+K^-)/\Gamma(D^0 \rightarrow \pi^+\pi^-) \simeq 2\text{-}5$, can be solved. Simultaneously, the contribution of the (QQ)(Q-barQ-bar) mesons explains why the violation of the $|\Delta I| = 1/2$ rule is small in the $K \rightarrow \pi\pi$ decays, while its charm counterpart is violated strongly. (author).

29474 (RRK–89-34) **Unified approach to weak decays of strange and charm mesons into two pseudoscalar mesons and the role of exotic mesons.** Terasaki, K.; Oneda, S. Hiroshima Univ., Takehara (Japan). Research Inst. for Theoretical Physics. Dec 1989. 39p. Order Number DE90777764. Available from NTIS (US Sales Only), PC A03/MF A01.

Basic nonleptonic weak decays of strange and charm mesons into two PS-mesons are studied. The amplitudes are cast into the form $M \simeq M_{ETC} + M_S \cdot M_{ETC}$ has now to be evaluated in the infinite momentum frame. M_S is described by the sum of asymptotic pole amplitudes and receives contributions from not only the ordinary {QQ-bar} mesons but also the exotics, i.e., [QQ][Q-barQ-bar] and (QQ)(Q-barQ-bar) mesons and glue-balls, etc. The contribution of the (QQ)(Q-barQ-bar) mesons explains why the violation of the $|\Delta I| = 1/2$ rule is small in the $K \rightarrow \pi\pi$ decays, while its charm counterpart is violated strongly. Glue-balls with $J^{PC} = 0^{++}$ can also play an interesting role in the Cabibbo-angle suppressed decays of the D^0 meson. The persistent puzzle of the ratio, $\Gamma(D^0 \rightarrow K^+K^-)/\Gamma(D^0 \rightarrow \pi^+\pi^-) \simeq 2\text{-}5$, can be solved simultaneously. (author).

29475 (UWThPh–1989-40) **Vector mesons and chiral symmetry.** Ecker, G. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 9p. Order Number DE90623710. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The ambiguities in the off-shell behaviour of spin-1 exchange can be resolved to $O(p^4)$ in the chiral low-energy expansion if the asymptotic behaviour of QCD is properly incorporated. As a consequence, the chiral version of vector (and axial-vector) meson dominance is model independent. Additional high-energy constraints motivated by QCD determine the V,A resonance couplings uniquely. In particular, QCD in its effective chiral realization sucessfully predicts $\Gamma(\rho \rightarrow 2\pi)$. 10 refs. (Author).

29476 (UWThPh–1989-41) **A light Zeldovich-Konopinski-Mahmoud neutrino with a large magnetic moment.** Ecker, G. (European Organization for Nuclear Research, Geneva (Switzerland)); Grimus, W.; Neufeld, H. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. Aug 1989. 7p. (CERN-Th–5485/89). Order Number DE90623690. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We propose a non-Abelian extension of a Zeldovich-Konopinski-Mahmoud lepton number symmetry which gives rise to a naturally light Dirac neutrino with a magnetic moment of $O(10^{-11}\,\mu_B)$. The neutrino mass appears first at the two-loop level and is well below the experimental upper bound. 13 refs., 3.figs. (Authors).

29477 (UWThPh–1989-43) **On the 'equivalent' potential to the Leutwyler-Voloshin model.** Bertlmann, R.A.; Hofer, P. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 10p. Order Number DE90623738. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We calculate the wave functions at origin of the 'equivalent' potential to the Leutwyler-Voloshin model and find that they reproduce the model results very well. 13 refs., 2 tabs. (Authors).

29478 (UWThPh–1989-54) **Supersymmetric quantum mechanics.** Grosse, H. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 31p. Order Number DE90623739. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We summarize recent developments of supersymmetric quantum mechanics. We start from the susy oscillator, mention the factorization schemes and discuss the order of levels of Schroedinger operators as an example. We mention soliton equation and the inverse scattering problem and discuss susy breaking and index problems for Dirac operators. The construction of Lie-supergroups suggests a generalization of the well-known theorems of von Neumann and Wigner to superspace. We mention finally studies of the general structure of susy models. A number of relations between the operator formulation and the stochastic formulation result. 25 refs., 2 tabs. (Author).

29479 (UWThPh–1989-55) **The classical geometry of Bosonic Strings.** Beig, R. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 5p. Order Number DE90623740. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We discuss a finite-dimensional 'canonical' framework for the bosonic string on an arbitrary curved background. 8 refs., 2 figs. (Author).

29480 (UWThPh–1989-64) **Quark jets, gluon jets and the three-gluon vertex.** Fodor, Z. (Roland Eoetvoes Univ., Budapest (Hungary). Inst. for Theoretical Physics). Vienna Univ. (Austria). Inst. fuer Theoretische Physik. Nov 1989. 20p. Order Number DE90623711. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Using hadronic jets in electron-positron annihilation, we suggest a simple and model-independent method to see the differences between quark and gluon jets. We define and analyse special energy dependent moments of jets and choose those which are the most characteristic to the jet type. The method handles the energy of a jet in an adequate way. We discuss new methods using jet flavor tagging, ordinary flavor tagging of a definite quark jet or discrimination between quark and gluon jets, to test the triple-gluon vertex in electron-positron annihilation. An enriched sample of gluon jets, jets with the smallest energy in four-jet events, as well as a continuous tagging variable are also studied. 21 refs., 6 figs. (Author).

29481 (UWThPh–1989-65) **Vector meson exchange in radiative kaon decays and chiral perturbation theory.** Ecker, G. (Vienna Univ. (Austria). Inst. fuer Theoretische Physik); Pich, A.; Rafael, E. de. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 15p. (FTUV–89-44;CPT–89/PE2325). Order Number DE90623691. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The role of vector meson resonances in radiative K decays is analyzed within the context of chiral perturbation theory. In general, there are big cancellations between strong amplitudes with external weak transitions and direct weak amplitudes, which are usually not considered in naive vector meson dominance estimates. We introduce a 'weak deformation model' inspired by the geometry of the coset space $SU(3)_R \times SU(3)_L/SU(3)_V$ to estimate the direct weak contributions to $K \rightarrow \pi\gamma^*$ and $K \rightarrow \pi\gamma\gamma$. The implications for the decay mode $K_L \rightarrow \pi^0 e^+ e^-$ are discussed. 23 refs., 4 figs., 1 tab. (Authors).

29482 (UWThPh–1990-9) **The status of the electric dipole moment of the neutron.** Grimus, W. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 26 Feb 1990. 21p. Order Number DE90623741. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The electric dipole moment of particles in quantum mechanics and quantum field theory is discussed. Furthermore, calculations of the neutron electric dipole moment in the standard model and several of its low-energy extensions are reviewed. 47 refs., 7 figs. (Author).

29483 **Phenomenology of the CKM matrix.** Nir, Y. (Stanford Linear Accelerator Center, Stanford University, Stanford, CA 94309 (US)). *AIP Conference Proceedings (American Institute of Physics) (USA)*, 196(1): 35-45 (15 Dec 1989). (CONF-8906204–: International symposium on heavy quark physics, Ithaca, NY (USA), 13-17 Jun 1989).

The way in which an exact determination of the CKM matrix elements tests the Standard Model is demonstrated by a two-generation example. The determination of matrix elements from

meson semileptonic decays is explained, with an emphasis on the respective reliability of quark level and meson level calculations. The assumptions invovled in the use of loop processes are described. Finally, the state of the art of our knowledge of the CKM matrix is presented.

29484 Symmetry, topology and helicity in $D_s \to \omega\pi$ and $D_s \to \rho\pi$ decays. Lipkin, H.J. (Department of Nuclear Physics, Weizmann Institute of Science, Rehovot 76100, Israel (IL)—School of Physics and Astronomy, Raymond and Beverly Sackler Faculty of Exact Sciences, Tel Aviv University, Tel Aviv, Israel—High Energy Physics/Physi *AIP Conference Proceedings (American Institute of Physics) (USA)*, 196(1): 72-78 (15 Dec 1989). DOE Contract W-31-109-ENG-38. (CONF-8906204–: International symposium on heavy quark physics, Ithaca, NY (USA), 13-17 Jun 1989).

Diagrams contributing to $D_s \to \omega\pi$ and $D_s \to \rho\pi$ decays are classified by topology as (a) OZI-forbidden or disconnected, (b) OZI-allowed or connected; by helicity as (a) helicity-conserving, (b) with helicity flips on both outgoing quark lines. The $D_s \to \omega\pi$ decay has an exotic final state and is forbidden for all annihilation diagrams which go via an intermediate state containing a single quark-antiquark pair and less than two additional gluons. It is also forbidden for helicity-conserving OZI-allowed diagrams, which are expected to be dominant and are allowed for $D_s \to \rho\pi$ decays.

29485 Non-perturbative QCD in weak decays. Sharpe, S.R. (University of Washington, Seattle, WA 98195 (US)). *AIP Conference Proceedings (American Institute of Physics) (USA)*, 196(1): 59-71 (15 Dec 1989). DOE Contract AS06-88ER40423. (CONF-8906204–: International symposium on heavy quark physics, Ithaca, NY (USA), 13-17 Jun 1989).

The status of nonperturbative calculations of hadronic matrix elements is reviewed, with particular emphasis on lattice results. New results are presented for B_K and for the $K^+ \to \pi^+\pi^0$ decay amplitude.

29486 Wormholes and Peccei-Quinn symmetries. Choi, K. (Department of Physics, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213 (US)); Holman, R. *Physical Review Letters (USA)*, 64(2): 131-134 (8 Jan 1990). DOE Contract AC02-76ER03066.

We show how wormholes and Peccei-Quinn symmetries are in fact complementary in solving the strong *CP* problem. On the one hand, Peccei-Quinn symmetries are shown to provide us with a wormhole parameter that couples only to the QCD anomaly. This then allows us to implement the wormhole solution to the strong *CP* problem constructed previously by the present authors as well as by Preskill, Trivedi, and Wise. On the other hand, wormholes are shown to drive the axion mass to zero or to the wormhole scale, thus avoiding the axion-energy-density crisis in either case.

29487 Scattering theory relevant to the linear transport of particle swarms. Frosali, G. (Virginia Polytechnic Institute and State Univ., Blacksburg (USA)); van der Mee, C.V.M. *Journal of Statistical Physics (USA)*, 56(1-2): 139-148 (Jul 1989).

The long-time behavior of the velocity distribution of a spatially uniform diluted guest population of charged particles moving within a host medium under the influence of a D.C. electric field is studied within the framework of scattering theory. The authors prove the existence of wave and scattering operators for a simplified one-dimensional model of the linearized Boltzmann equation. The theory is applied to the study of the long-term behavior of electrons and the occurrence of traveling waves in runaway processes.

6453 Particle Invariance Principles and Symmetries

Refer also to citation(s) 29460, 29491

29488 (CEA-CONF–9521) **Superconformal models and the supersymmetric coulomb gas.** Saleur, H. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique. Mar 1988. 7p. (CONF-8803253–: 3. annecy meeting in theoretical physics on conformal field theory and related topics, Annecy (France), 14-16 Mar 1988). Order Number DE90770196. Available from NTIS (US Sales Only), PC A02/MF A01.

The obtention of the supersymmetric 19-vertex model from an inhomogeneous 6-vertex model, is discussed. The 19-vertex model is considered the underlying theory and applied to calculate the partition function of the torus. A similar scheme to that for the critical models obtention, concerning the restriction procedure at special points of the gaussian line (of the 6-vertex model) is used. The critical line, in the supersymmetric model, is described by a free superfield and related to the XY model. The "fused" lattice models are outlined. It is shown that the results can be generalized to the models obtained by SU(2) coset construction.

29489 (CEA-CONF–9522) **Properties of the stress tensor in more than two dimensions.** Cappelli, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique); Coste, A. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique Theorique. Mar 1988. 8p. (CONF-8803253–: 3. annecy meeting in theoretical physics on conformal field theory and related topics, Annecy (France), 14-16 Mar 1988). Order Number DE90770195. Available from NTIS (US Sales Only), PC A02/MF A01.

Some aspects of conformal invariance in more than two dimensions are analysed. In this case conformal (Weyl) transformations of the metric are not realized in general by coordinate transformations. The operator product expansion of the stress tensor is investigated by means of examples in the free bosonic and fermionic theories. The effective action for the general form of the trace anomaly is built in four dimensions and the Wess-Zumino consistency conditions are discussed. This gives the anomalous transformation law of the stress tensor and the relation to the Casimir effect in the geometry $R \times S^3$. The explicit computation of the bosonic partition function provides a check.

29490 (INS–783) **Higher-spin symmetry in one and two dimensions, (2).** Fradkin, E.S. (AN SSSR, Moscow (USSR). Fizicheskij Inst.); Linetsky, V.Ya. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Oct 1989. 27p. Order Number DE90777708. Available from NTIS (US Sales Only), PC A03/MF A01.

Constructed are conformal higher spin superalgebras in one and two dimensions, which contain the Virasoro algebra as a subalgebra. The general structure of these super algebras is investigated. (author).

6454 Field Theory

Refer also to citation(s) 28427, 29334, 29479, 29520

29491 (INS–788) **Magnetic properties of three-dimensional Hubbard-sigma model.** Yamamoto, Hisashi; Ichinose, Ikuo; Tatara, Gen; Matsui, Tetsuo. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Nov 1989. 50p. Order Number DE90777711. Available from NTIS (US Sales Only), PC A03/MF A01.

It is broadly viewed that the magnetism may play an important role in the high-T_c superconductivity in the lamellar CuO_2 materials. In this paper, based on a Hubbard-inspired CP^1 or S^2 nonlinear σ model, we give a quantitative study of some magnetic properties in and around the Neel ordered state of three-dimensional quantum antiferromagnets such as La_2CuO_4 with and without small hole doping. Our model is a (3+1) dimensional effective field theory describing the low energy spin dynamics of a three-dimensional Hubbard model with a very weak interlayer coupling. The effect of hole dynamics is taken into account in the leading approximation by substituting the CP^1 coupling with an 'effective' one determined by the concentration and the one-loop correction of hole fermions. A stationary-phase equation for the one-loop effective potential of S^2 model is analyzed numerically. The behavior of Neel temperature, magnetization (long range Neel order), spin correlation length, etc as functions of anisotropic parameter, temperature, hole concentrations, etc are investigated in detail. A phase diagram is also supported by the renormlization group analysis. The results show that our anisotropic field theory model with certain values of parameters could give a reasonably well description of the magnetic properties indicated by some experiments on pure and doped La_2CuO_4. (author).

29492 (INS–795) **Spontaneous compactification and structure of gauge vacua in six-dimensional gauge theory.** Nakamura, A. (Tokyo Metropolitan Univ. (Japan). Dept. of Physics); Shiraishi, K. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Nov 1989. 17p. Order Number DE90777714. Available from NTIS (US Sales Only), PC A03/MF A01.

We consider an SU(2) gauge theory in six-dimensions. We show that there exists non-trivial structure of gauge vacua in compactified background $M^4 \times S^2$. In this circumstances, there can exist a cosmic string, whose solution is recently constructed by the present authors. We consider the stage of the formation of the strings, i.e., the phase transition of the gauge configuration on the sphere in the 'hot' early universe. We find that if SU(2)-doublet fermions are the dominant component of the radiation at high temperatures, the phase transition successively occurs after the spontaneous-compactification transition. Otherwise, non-trivial vacuum with 'monopole' configuration of the SU(2) gauge field never appears globally and strings must be formed at the same time as the extra space is compactified. (author).

29493 (NBI-HE–89-62) **The O(N)-symmetric non-linear σ-model to three leading orders in 1/N.** Flyvbjerg, H.; Varsted, S. Niels Bohr Inst., Copenhagen (Denmark). Dec 1989. 14p. (CONF-8908189–: Workshop on probabilistic methods in quantum field theory and quantum gravity, Cargese (France), 21-27 Aug 1989). Order Number DE90623403. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The two-point function of the O(N)-symmetric non-linear σ-model is expanded in 1/N, keeping terms of three leading orders. The mass gap and the magnetic susceptibility are obtained from the two-point function. They are evaluated on square lattices for N=3 and N=4. The systematic errors of the 1/N-series truncated after the first, second, or third term are found by using recent high precision Monte Carlo results as bench marks. For all three truncations, we find systematic errors which are smaller than the expected magnitude of neglected terms, both for the mass gap and for the susceptibility. This result is uniform in the inverse coupling β, and valid for N as small as 3. We conclude that the 1/N-series approach the exact results as rapidly as one could ever hope for. (orig.).

29494 (RRK–89-23) **Some aspects of quantum groups and supergroups.** Corrigan, E. (Durham Univ. (UK). Dept. of Mathematical Sciences); Fairlie, D.B.; Fletcher, P.; Sasaki, R. Hiroshima Univ., Takehara (Japan). Research Inst. for Theoretical Physics. Jul 1989. 17p. Order Number DE90777884. Available from NTIS (US Sales Only), PC A03/MF A01.

The paper concentrates upon certain algebraic aspects of the quantum inverse scattering theory and develops ideas arising principally from the viewpoint of Manin, who considers a quantum group as effecting linear transformations upon a space whose elements are non-commutative. The conditions for such a mapping to be an endomorphism constitute the quantum group relations. In fact, since this idea underlies the classical transformation groups, it is a very natural, though at first sight unfamiliar, approach to the deformation of classical groups. The idea of Manin is recounted for the simplest example of GLq(2) and develop properties of this quantum group. A natural extension leads to the definition of the dual group GLq(2) whose elements are Grassmannian, and GLq(1/1) which is connected with the quantum extension of the superalgebra SU(1/1), just as GLq(2) is connected with the quantum extension of SU(2). These groups are then displayed in a more familiar way as bilinear relations specified by an R-matrix satisfying the Yang-Baxter equation. The minimal set of relations imposed by the R-matrix relations is shown to be equivalent to those imposed by Manin's construction, and in fact, Manin's construction can be used to infer the structure of the R-matrix for the classical groups. (N.K.).

29495 (RRK–89-26) **Aspects of perturbed conformal field theory, affine Toda field theory and exact S-matrices.** Braden, H.W. (Durham Univ. (UK)); Corrigan, E.; Dorey, P.E.; Sasaki, R. Hiroshima Univ., Takehara (Japan). Research Inst. for Theoretical Physics. Jul 1989. 14p. Order Number DE90777887. Available from NTIS (US Sales Only), PC A03/MF A01.

Zamolodchikov suggests the hypothesis that the perturbed theory is actually an integrable theory of eight massive bosons. Following this development, the aim of the present study is to try to discover what this integrable theory is by conjecturing a candidate, and testing Zamolodchikov's arguments. On the way, a number of interesting facts are discovered concerning affine Toda field theory and two-dimensional factorisable S-matrices. It seems that this by itself warrants further investigation. Thus, in the report, the Zamolodchikov's strategy is outlined first, and then factorisable S-matrices are discussed on the assumption that the interesting theories contain self-conjugate particles only, with distinct masses. In the next section, the report describes a simple field theory which is certainly related to the S-matrix Zamolodchikov describes and which might be used as a framework within which to explore further. In any case, it seems that the connection with Toda theory is by itself interesting and revives interest in work begun many years ago. Finally, other affine Toda theories are also discussed briefly. (N.K.).

29496 (UWThPh–1989-35) **On the classical geometry of bosonic string dynamics.** Beig, R. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 14p. Order Number DE90623404. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We develop a treatment of bosonic strings on a general curved background in which the volume element and the coordinates of the worldsheet are related in a similar way as canonically conjugate quantities in mechanics. The resultant formalism is a particular variant of the multi-phase space approach to classical field theory put forward by Kijowski, Tulczyjew and others. We study conservation laws within this framework and find that all conserved quantities are related to point symmetries, i.e. isometries of the underlying spacetime. Thus the symmetries of relativistic mechanics coming from Killing-tensors have no analogue here. We furthermore deduce from the present scheme the covariant version of the usual phase space. 14 refs. (Author).

29497 (UWThPh–1989-46) **Covariant virasoro operators.** Embacher, F. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 9p. Order Number DE90623405. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The concept of 'covariant Virasoro operators' is defined, and some applications to the open bosonic string field theory are given. 17 refs. (Author).

29498 (UWThPh–1989-66) **Renormalizable ultraviolet finite three dimensional gauge model.** Krasnikov, N.V. (Academy of Sciences of the USSR. Moscow (USSR). Inst. for Nuclear Research); Kyatkin, A.B.; Tavkhelidze, N.A. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 7p. Order Number DE90623406. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We construct a renormalizable ultraviolet finite three dimensional gauge model. We show that three dimensional quantum electrodynamics without a kinetic term for the electromagnetic field is renormalizable and ultraviolet finite in the framework of the 1/N expansion. The generalization of our results to the nonabelian case are briefly discussed. 7 refs., 2 figs. (Author).

29499 (UWThPh–1989-67) **Abelization by operator equivalence in string theory.** Embacher, F. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 25p. Order Number DE90623407. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

An operator is presented which transforms the 'true' bosonic open-string BRST charge into the 'abelized' one. The same transformation relates the transverse DDF-operators with the transverse elementary oscillators. This allows a simple realization of the light-cone gauge condition in the convariant Fock-space. Furthermore, some light is shed upon the concept of covariant Virasoro operators. Finally, the functional representation of the abelizing operator is given, and some speculations about string field theory and string interactions are made. 23 refs. (Author).

29500 (UWThPh–1989-73) **On quantum field theories with Galilei-invariant interactions.** Namhofer, H.; Thirring, W. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 7p. Order Number DE90623408. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

We show that for fermions interacting with potentials with a momentum cut-off the Hamiltonian is stable and defines a time

evolution in the Heisenberg representation: A mixing property of these systems is derived. 10 refs. (Authors).

29501 (UWThPh–1989-76) **The fiber bundle formalism for the quantization in curved spaces.** Wyrozumski, T. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 14p. Order Number DE90623409. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We set up a geometrical formulation of the canonical quantization of free Klein-Gordon field on a gravitational background. We introduce the notion of the Bogolubov bundle as the principal fiber bundle over the space of all Cauchy surfaces belonging to some fixed foliation of space-time, with the Bogolubov group as the structure group, as a tool in considering local Bogolubov transformations. Sections of the associated complex structure bundle have the meaning of attaching Hilbert spaces to Cauchy surfaces. We single out, as physical, sections defined by the equation of parallel transport on the Bogolubov bundle. The connection is then subjected to a certain nonlinear differential equation. We find a particular solution, which happens to coincide with a formula given by L.Parker for Robertson-Walker space-times. Finally, we adopt the adiabatic hypothesis as the physical input to the formalism and fix in this way a free parameter in the connection. Concluding, we comment on a possible geometrical interpretation of the regularization of stress-energy tensor and on generalizations of the formalism toward quantum gravity. 14 refs. (Author).

29502 **New mean field theories of the Hubbard model.** Krishnamurthy, H.R, (Princeton Univ., Princeton, NJ (US)); Jayaprakash, C.; Wenzel, W.; Sarker, S. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). Grant DNR8518163. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors summarize some of the results they have obtained in recent studies of the Hubbard model on the square and triangular lattices. They utilize spin-boson, slave-fermion mean filed theories and the Hartree-Fock mean field theory allowing for xy-SPIRAL spin order.

29503 **Noether's theorem for local gauge transformations.** Karatas, D.L. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439 (US)); Kowalski, K.L. *American Journal of Physics (USA),* 58(2): 123-131 (Feb 1990). DOE Contract W-31-109-ENG-38.

The variational methods of classical field theory may be applied to any theory with an action that is invariant under local gauge transformations. What is the significance of the resulting Noether current? This article examines such currents for both Abelian and non-Abelian gauge theories and provides an explanation for their form and limited range of physical significance on a level accessible to those with a basic knowledge of classical field theory. Several of the more subtle aspects encountered in the application of the residual local gauge symmetry found by Becchi, Rouet, Stora, and Tyutin are also considered in detail in a self-contained manner.

65 PHYSICS II

29504 **Comment on "Theory of electronic diamagnetism in two-dimensional lattices".** Nicopoulos, V.N. (Los Alamos National Laboratory, Theoretical Division, MS B262, Los Alamos, New Mexico 87545 (US)); Trugman, S.A. *Physical Review Letters (USA),* 64(2): 237 (8 Jan 1990).

A Comment on the Letter by Hasegawa *et al.*, Phys. Rev. Lett. 63, 907 (1989).

6510 Nuclear Physics

Refer also to citation(s) 29907

29505 (ANL/NDM–114) **Ambiguities in the elastic scattering of 8 MeV neutrons from adjacent nuclei.** Smith, A.B.; Lawson, R.D.; Guenther, P.T. Argonne National Lab., IL (USA). Oct 1989. 45p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90009518. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Ratios of the cross sections for elastic scattering of 8 MeV neutrons from adjacent nuclei are measured over the angular range $\approx 20° - 160°$ for the target pairs ^{51}V/Cr, ^{59}Co/^{58}Ni, Cu/Zn, ^{89}Y/^{93}Nb, ^{89}Y/Zr, ^{93}Nb/Zr, In/Cd and ^{209}Bi/Pb. The observed ratios vary from unity by as much as a factor of ≈ 2 at some angles for the lighter target pairs. Approximately half the measured ratios are reasonably explained by a simple spherical optical model, including size and isospin contributions. In all cases, the geometry of the real optical–model potential is essentially the same for neighboring nuclei, and the real–potential strengths are consistent with the Lane model. In contrast, it is found that the imaginary potential may be quite different for adjacent nuclei, and the nature of this difference is examined. It is shown that the spin–spin interaction has a negligible effect on the calculation of the elastic–scattering ratios, but that channel coupling, leading to a large reorientation of the target ground state, can be a consideration, particularly in the ^{59}Co/^{58}Ni case. In the $A \approx 50–60$ region the calculated ratios are sensitive to spin–orbit effects, but the exact nature of this interaction must await more definitive polarization measurements. The measured and calculated results suggest that the concept of a conventional "global" or even "regional" optical potential provides no more than a qualitative representation of the physical reality for a number of cases. 48 refs., 14 figs., 3 tabs.

29506 (INIS-SU–166) **Nuclear spectroscopy and nuclear structure. Electromagnetic transitions in atomic nuclei: Summaries of report.** AN SSSR, Moscow (USSR); Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR); AN Uzbekskoj SSR, Tashkent (USSR). Inst. Yadernoj Fiziki. 1989. 613p. (In Russian). (CONF-8904337–: 39. conference on nuclear spectroscopy and nuclear structure, Tashkent (USSR), 18-21 Apr 1989). Order Number DE90706082. Available from NTIS (US Sales Only), PC A99/MF A01; OSTI; INIS.

Individual papers are processed separately for the data base. (DLC)

29507 (JAERI-M–90-025) **Proceedings of the 1989 seminar on nuclear data.** Nakajima, Yutaka (ed.) (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Igashira, Masayuki (ed.). Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment. c Feb 1990. 413p. (NEANDC(J)–149/U;INDC(JPN)–136/L;CONF-8911182–: 1989 seminar on nuclear data, Tokai (Japan), 16-17 Nov 1989). Available from Japan Atomic Energy Research Institute, Department of Technical Information, Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan.

The 1989 Seminar on Nuclear Data was held at the Tokai Research Establishment of Japan Atomic Energy Research Institute, on November 16 and 17, 1989. This Seminar was organized by the Japanese Nuclear Data Committee (JNDC) and the Nuclear Data Center, JAERI. In an oral session, review and benchmark tests of JENDL-3 were presented, which were followed by a lively discussion. The need of nuclear data other than neutron induced reaction data were also presented. In addition, several topical talks were given. In a poster session, twenty papers on evaluation and measurement were presented and discussed. In these proceedings, thirty-four papers given in the seminar are compiled.

29508 (KEK–89-12) **Proceedings of the workshop on the experiments by polarized proton and electron beams.** Hasegawa, Takeo (Miyazaki Univ. (Japan)); Hiramatsu, Shigenori; Horikawa, Naoaki; Nakanishi, Tsutomu; Tamae, Tadaaki (eds.). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Sep 1989. 237p. (CONF-8810498–: Workshop on the experiments by polarized proton and electron beams, Tsukuba (Japan), 27-28 Oct 1988). Order Number DE90777829. Available from NTIS (US Sales Only), PC A11/MF A01.

This issue is the collection of the papers presented at the title meeting. The 21 of the presented papers are indexed individually. (J.P.N.).

29509 (NAC-AR-86-01, pp. 191-204) **Nuclear reactions and structure: Reactions involving neutrons and reactions induced by alpha-particles. .** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Information on the level structure of nuclei is extended and new and refined information about specific nuclear reaction mechanisms and nuclear interactions is provided. 7 figs., 18 refs.

29510 (ORNL/FTR-3575) **[Supercomputing in nuclear applications]: Foreign trip report, March 12-22, 1990.** Kirk, B.L. Oak Ridge National Lab., TN (USA). 9 Apr 1990. 25p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE90009829. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the first international conference on supercomputing in nuclear applications. The traveler presented a paper on parallel processing of the nodal diffusion method. The traveler visited JAERI, NEDAC, Hitachi Works, CRC and CTCC. At JAERI and NEDAC, the traveler made a presentation on RSIC activities. The traveler then proceeded to the Philippines where she visited PNRI, made an RSIC orientation visit and presented the SNA 90 paper and had several discussions with PNRI staff.

29511 (ORNL/FTR-3586) **[Nuclear structure and decay data]: Foreign trip report, March 8, 1990-March 31, 1990.** Martin, M.J. Oak Ridge National Lab., TN (USA). 10 Apr 1990. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009865. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler participated in the meeting, the main purpose of which was to continue the coordination and development of the international network of centers devoted to the compilation, evaluation, and exchange of mass-chain nuclear structure and decay data. Following the meeting, the traveler spent an extra week in Kuwait, and visited the data centers in Beijing and Shanghai for more detailed discussions on specific problems in data evaluation and presentation.

29512 (ORNL/FTR-3591) **[The 28th meeting of the Nuclear Energy Agency Nuclear Data Committee]: Foreign trip report, March 26, 1990-March 30,,1990.** Perey, F.G. Oak Ridge National Lab., TN (USA). 16 Apr 1990. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009866. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended the 28th meeting of the NEANDC at Harwell, England. Extensive reorganization of the UK Atomic Energy Authority will severely impact the cross-section work at Harwell. International collaboration on nuclear data evaluation is proceeding smoothly. Changes in handling the separated isotopes in DOE's Research Material Collection will have a serious impact on nuclear data measurements of interest to the United States.

29513 (RCNP-P-107) **Proceedings of the workshop on 'cyclotron cascade project'.** Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. 242p. (In Japanese). (CONF-8903211-: Workshop on cyclotron cascade project, Ibaraki (Japan), 13-15 Mar 1989). Order Number DE90777870. Available from NTIS (US Sales Only), PC A11/MF A01.

This issue is the collection of the papers presented at the title meeting. The 29 of the presented papers are indexed individually. (J.P.N.).

29514 (UCRL-50400-Vol.6-Rev.4-Pt.A) **Tables and graphs of photon-interaction cross sections from 10 eV to 100 GeV derived from the LLNL [Lawrence Livermore National Laboratory] Evaluated Photon Data Library (EPDL): Volume 6: Rev. 4: Part A, Z = 1 to 50.** Cullen, D.E.; Chen, M.H.; Hubbell, J.H.; Perkins, S.T.; Plechaty, E.F.; Rathkopf, J.A.; Scofield, J.H. Lawrence Livermore National Lab., CA (USA). 31 Oct 1989. 374p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010470. Available from NTIS, PC A16/MF A01 - OSTI; GPO Dep.

Energy-dependent evaluated photon interaction cross sections and related parameters are presented for elements H through Fm (Z = 1 – 100). Data are given over the energy range from 10 eV to 100 GeV. Cross sections, average energy deposits, and form factors are presented in tabulated and graphic form. In addition, photoelectric cross sections for each shell and coherent anomalous scattering factors are presented in graphic form. This information is derived from the Livermore Evaluated Photon Data Library (EPDL) as of October 1989. This publication is divided into two parts. Part A, Z = 1 to 50 and Part B, Z = 51 to 100.

29515 (UCRL-50400-Vol.6-Rev.4-Pt.B) **Tables and graphs of photon-interaction cross sections from 10 eV to 100 GeV derived from the LLNL Evaluated Photon Data Library (EPDL): Volume 6, Part B, Z = 51 to 100: Revision 4.** Cullen, D.E.; Chen, M.H.; Hubbell, J.H.; Perkins, S.T.; Plechaty, E.F.; Rathkopf, J.A.; Scofield, J.H. Lawrence Livermore National Lab., CA (USA). 31 Oct 1989. 452p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010469. Available from NTIS, PC A20/MF A01 - OSTI; GPO Dep.

Energy-dependent evaluated photon interaction cross sections and related parameters are presented for elements H through Fm (Z = 1–100). Data are given over the energy range from 10 eV to 100 GeV. Cross sections, average energy deposits, and form factors are presented in tabulated and graphic form. In addition, photoelectric cross sections for each shell and coherent anomalous scattering factors are presented in graphic form. This information is derived from the Livermore Evaluated Photon Data Library (EPDL) as of October 1989. This publication is divided into two parts: Part A, Z = 1 to 50 and Part B, Z = 51 to 100.

29516 Valency in actinide systems as viewed by neutron scattering. Lander, G.H. (Argonne National Lab., IL (USA)). pp. 44 of American Chemical Society, Division of Nuclear Chemistry and Technology. American Chemical Society, Washington, DC (US) (1986). (CONF-8609360-: Symposium on solid-state actinide chemistry and physics, Anaheim, CA (USA), 7-12 Sep 1986).

Of central importance in studying actinide systems is the question of how many unpaired 5f electrons surround the actinide nucleus, and what is their interaction with other electrons - either the conduction electrons in metals or the d - p orbitals of neighboring anions. The magnetic moment of the neutron interacts directly with those of the unpaired electrons in the solid and thus can, in principle, answer this important question. Two examples will be presented. The first is the ionic compound UCl_4 where, for the first time, their experiments show how the f electrons participate in the bonding. The second is the metallic system PuSb, where the 5f electrons appear localized (Pu^{3+}) but their experiments indicate deviations from localized behavior caused by interaction with the conduction electrons. New experiments on PuTe will be contrasted with those on PuSb. The extension of this work to other covalent actinide systems will be discussed.

6511 Experimental Techniques

Refer also to citation(s) 29516

29517 (BNL-44430) **810 Future plans.** Etkin, A. (Brookhaven National Lab., Upton, NY (USA)); Foley, K.J.; Hackenburg, R.W.; Longacre, R.S.; Love, W.A.; Morris, T.W.; Platner, E.D.; Saulys, A.C.; Lindenbaum, S.J.; Chan, C.S. E-810 Collaboration. Brookhaven National Lab., Upton, NY (USA). 27 Mar 1990. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016;AC02-83ER40107;AS05-81ER40032;AC02- (CONF-900331-1: Heavy ion physics at the alternating gradient synchrotron, Upton, NY (USA), 5-7 Mar 1990). Order Number DE90009526. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

It is believed that a good bet for finding the Quark-Gluon Plasma at AGS energies is with the heaviest projectiles on the heaviest target, i.e. Au on Au. One of the likely signatures of the plasma is strangeness enhancement. Al Saulys has shown what it's like to find Δ and K° with Si projectiles. Our Monte Carlo simulations show track densities 4 times higher for Au projectiles. In addition, the Au beam itself produces 30 times more ionization. Thus the

present TPC's will be limited to only a few hundred ions per sec. This paper discusses plans for these experiments and modification to TPC. 9 figs.

29518 (DOE/ER/40415–12) **Magnetic electron scattering.** Peterson, G.A. Massachusetts Univ., Amherst, MA (USA). Dept. of Physics and Astronomy. [1989]. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER40415. (CONF-8911179–1: 6. Amsterdam miniconference, Amsterdam (Netherlands), 16-17 Nov 1989). Order Number DE90009127. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We briefly review some of the motivations, early results, and techniques of magnetic elastic and inelastic electron-nucleus scattering. We then discuss recent results, especially those acquired at high momentum transfers. 50 refs., 19 figs.

29519 (GANIL-P–89-16) **Properties of light nuclei very far from beta stability.** Detraz, C. Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France). 1989. 20p. (CONF-890826–: International nuclear physics and cosmology conference, Sao Paulo (Brazil), 20-26 Aug 1989). Order Number DE90770334. Available from NTIS (US Sales Only), PC A03/MF A01.

This paper will be devoted to underlying the major developments which occurred in the study of light nuclei far from the valley of stability since the last International Nuclear Physics Conference in Harrogate (1986) where that field of research was already presented (1). A broader review will appear elsewhere (2). Therefore only some highlights are presented and discussed here. Probably the main development of the field in recent years has to do with a change in its aims and methods. The goal is no longer to search for individual hitherto unobserved nuclear species and to report their existence. It has become to study the major nuclear properties such as binding energy, half life, size, decay modes over broad ranges of neighbouring isotopes extending very far from stability in order to put to a test the current nuclear models based essentially on observations of nuclei near the stability line.

29520 Nucleus-nucleus collisions at relativistic energies: The CERN WA80 experiment. . Plasil, P. (Oak Ridge National Lab., TN (USA)); Awes, T.C.; Bakatash, C.; Ferguson, R.L.; Johnson, J.W.; Lee, I.Y.; Obenshain, F.E.; Sorensen, S.P.; Young, G.R.; Albrecht, R. pp. 541 of Proceedings of the 6th Adriatic international conference on nuclear physics: Frontiers of heavy-ion physics. Cindro, N.; Caplar, R.; Greinder, W. World Scientific Pub. Co., Teaneck, NJ (USA) (1987). DOE Contract AC05-84OR21400. (CONF-8706113–: 6. Adriatic international conference on nuclear physics: frontiers of heavy-ion physics, Dubrovnik (Yugoslavia), 15-19 Jun 1987).

QCD lattice calculations predict that, at sufficiently high energy densities, hadronic matter undergoes a transition to a new phase of matter, the quark-gluon plasma, in which quarks and gluons are deconfined over a relatively large volume. It has been suggested that collisions between heavy nuclei at ultrarelativistic energies may produce the energy densities, estimated to be greater than 2-3 GeV/fm^3, necessary for this phase transition to occur. An important goal of the first experiments with ultrarelativistic heavy-ion beams at the SPS accelerator at CERN is to investigate the extent to which this suggestion is correct. The primary experimental quantity used for estimating the energy density is the transverse energy, E_T. The authors present energies measured at zero degrees, together with transverse energy measurements. Estimates of attained energy densities and preliminary transverse momentum distributions of neutral products are also presented.

6512 Nuclear Properties and Reactions, A = 1-5, Experimental

29521 (KEK–89-15) **Tests for cold fusion in electrochemically deuterized palladium.** Isagawa, S.; Kanda, Y.; Kondo, K.; Miyajima, M.; Sasaki, S.; Suzuki, T.; Yukawa, T. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Oct 1989. 17p. Order Number DE90777759. Available from NTIS (US Sales Only), PC A03/MF A01.

Two recent papers have reported positive detection of nuclear radiation from similar electrochemical cells operating with deuterated water. We have attempted to confirm this cold nuclear fusion by detecting neutrons and tritiums using similar electrolytic cells. A variety of electrochemical cells having palladium cathodes in the forms of tubes and rods, and electrolytes were examined. So far we have observed no statistically significant evidence for neutron emission and generation of tritium, after running for times up to about one month. (author).

29522 (RCNP-P–106, pp. 86-89) **Structure of the $_\Sigma{}^4$He hypernuclear bound state.** Harada, T. (Hokkaido Univ., Sapporo (Japan). Faculty of Science). Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

The structure of $_\Sigma{}^4$He is theoretically investigated on the basis of realistic ΣN interaction. The bound state has spin-parity $J^\pi = 0^+$ and isospin $T \approx 1/2$ (99 %), binding energy $B_{\Sigma^+} = 3.7 \approx 4.6$ MeV and a narrow ΣN → ΛN conversion width of $\Gamma = 4.5 \approx 7.9$ MeV, which are in agreement with experimental data obtained at KEK. The existence of the Σ-bound state with such a narrow width is explained from characteristic properties of the nucleus-Σ potential derived from the microscopic four-body calculation. (author).

29523 (RCNP-P–106, pp. 77-85) **Production and structure of light Σ hypernuclei: Summary of the few body XII invited talk. .** Hayano, R.S. (Tokyo Univ. (Japan). Dept. of Physics). Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

Recent developments on experimental and theoretical studies on light Σ hypernuclei are presented. The ^{4}He(K^-, π^-) experiment by the Tokyo group, aiming at the search for the Σ hypernuclear ground state, has shown the existence of a peak in the Σ bound region. Comparisons of this result with various theoretical expectations are made. (author).

29524 (RCNP-P–106, pp. 45-51) **Equation for the NNN-πNNN system and its application to pd → ^{3}Heπ^0 ($t\pi^+$) reaction.** Ueda, Tamotsu (Osaka Univ., Toyonaka (Japan). Faculty of Engineering Science). Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

A relativistic and unitary theory for the systems of NNN - πNNN in the Δ production energy region is presented. The systems are approximated by the plural three- and two-body systems which couple through multi-channel two-body interactions. A Faddeev-type equation is given in the form of one-variable integral equation in the three dimensions, while equivalent to the four-dimensional covariant form. The equation describes all the reactions among the Nd, ^{3}He(t)π, NNN and Ndπ system in a unified way. An application is made to pd - ^{3}He $\pi^0(t\pi^+)$ reaction with the approximation that the NNΔ system dominates in the intermediate state through the $J^P = 2^+$ isotriplet-dibaryonic two-body interaction. A remarkable finding is that the $J^P = 5/2^+$ amplitude makes an anticlockwise loop in the Argand plot with its magnitude maximum about 30 MeV below the NNΔ threshold, suggesting the existence of a quasi-bound state of the NNΔ system. Furthermore, the origin for a spike structure in the energy dependence of the tensor polarization of deuteron at T_d = 400-600 MeV is explained. (author).

29525 (RCNP-P–106, pp. 39-44) **Deuteron breakup reaction with strong p-n final state interaction.** Okamura, H. (Institute of Physical and Chemical Research, Wako, Saitama (Japan)). Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (CONF-8905289–: Workshop on few-body systems, Ibaraki

(Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

The deuteron breakup reaction has been studied at E_d = 56 and 70 MeV in a kinematically complete coincidence measurement of p-n pairs with small relative energies. The singlet deuterons ($d_{s=0}$) have been successfully selected. It is demonstrated that the ($d,d_{s=0}$) reaction is a useful tool for the study of the inelastic excitation of the spin- and isospin-flip mode. The elastic breakup reaction at θ = 0deg has been also studied. A conspicuous double-peaked structure in the p-n relative momentum and a characteristic dependence of the cross section on targets are observed. These features are analyzed in terms of the pure Coulomb breakup of the deuteron. (author).

29526 (RCNP-P–106, pp. 34-38) **0 deg measurement of ^{3}He(p,n)^{3}LI and ^{2}H(d,d*)d reactions.** Okihana, Akira (Kyoto Univ. of Education (Japan)). Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

The ^{3}He(p,n)^{3}Li and ^{2}H(d,d*)d* reactions have been measured at 0deg. The spectrum of neutrons from the ^{3}He(p,n)^{3}Li reaction at 65 MeV at 0deg was reproduced without 3p resonances or states. The spectrum of pn coupled to the singlet state from the ^{2}H(d,d*)d* reaction at 56 MeV at 0deg was reproduced with the Watson-Migdal theory. (author).

29527 (RCNP-P–106, pp. 12-14) **Energy dependence of the ^{2}H(d,dp)n reaction.** Hayashi, T. (Kyoto Univ. (Japan). Dept. of Physics); Fukunaga, K.; Kakigi, S.; Ohsawa, T.; Okihana, A.; Sekioka, T.; Nakamura-Yokota, H.; Murayama, T. Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

Energy dependence of the cross section and the vector analyzing power A_y for the ^{2}H(d,dp)n reaction were measured at E_d = 54.6, 56.7, 59.6, 61.7 MeV in the QFS conditions. The experimental data were compared with the PWIA calculation. The cross section changes very slowly with energy, and shows no sharp dip that G.Hrehuss et.al. reported. The analyzing power A_y also shows no structure. (author).

29528 (RCNP-P–106, pp. 10-11) **Analyzing power for the ^{3}He(d,dd)^{1}H reaction at 59.5 MeV.** Sekioka, T. (Himeji Inst. of Tech., Hyogo (Japan)); Fukunaga, K.; Kakigi, S.; Ohsawa, T.; Hayashi, T.; Okihana, A. Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

The ^{3}He(d,dd)^{1}H reaction was investigated with a vector polarized deuteron beam at 59.5 MeV in the quasifree scattering (QFS) conditions. The analyzing powers were obtained at nine coincidence angle pairs. They are compared with the analyzing powers for the dd elastic scattering with deuteron beam energy of 56 MeV. The maximum value of A_y is reduced considerably compared with that for the dd elastic scattering. A calculation of the A_y for the QFS bumps taking account of multiple scattering effect is in progress. (author).

29529 (RCNP-P–106, pp. 6-9) **Three-body breakup contribution to the spectral function of ^{4}He.** Morita, H. (Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics); Suzuki, T. Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

We calculate the three-body break up contribution to the spectral function of ^{4}He within the plane-wave approximation. The realistic spectral function has pronounced high- momentum and excitation energy components caused by the NN correlation. (author).

29530 (RCNP-P–106, pp. 149-152) **Analyzing powers in p+d scattering at low energy.** Sagara, K. (Kyushu Univ., Fukuoka (Japan). Dept. of Physics); Nakamura, H.; Nakashima, M.; Maeda, K.; Izumi, M.; Yamaoka, T.; Nakashima, T. Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

Analyzing powers of H(d,d) scattering at 14 MeV were measured at very forward angles up to 3deg (lab). The tensor analyzing powers reflect apparent Coulomb-nuclear interference effect at around 5deg (lab). The data are compared with Faddeev calculations with/without the Coulomb force. (author).

6513 Nuclear Properties and Reactions, A = 6-19, Experimental

29531 (RCNP-P–106, pp. 74-76) **Search for the H dihyperon by double weak decay of nuclei.** Ejiri, H. (Osaka Univ., Toyonaka (Japan). Dept. of Physics); Kishimoto, T.; Ohsumi, H.; Tanaka, J.; Kashitani, A.; Takasugi, E. Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

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29532 **The double resonance in the ^{12}C + ^{15}N reaction.** Freeman, R.M. (Centre de Recherches Nucleaires and Universite Louis Pasteur 67037 Strasbourg Cedex (France)). pp. 541 of Proceedings of the 6th Adriatic international conference on nuclear physics: Frontiers of heavy-ion physics. Cindro, N.; Caplar, R.; Greinder, W. World Scientific Pub. Co., Teaneck, NJ (USA) (1987). (CONF-8706113–: 6. Adriatic international conference on nuclear physics: frontiers of heavy-ion physics, Dubrovnik (Yugoslavia), 15-19 Jun 1987).

Short communication CARBON 12 REACTIONS/double resonance methods; NITROGEN 15 REACTIONS/double resonance methods; GAMMA RADIATION; YIELDS; EXPERIMENTAL DATA; PARTICLE KINEMATICS; COLLECTIVE EXCITATIONS; INELASTIC SCATTERING; MEV RANGE 01-10; MEV RANGE 10-100; COINCIDENCE METHODS

6514 Nuclear Properties and Reactions, A = 20-38, Experimental

29533 (DOE/ER/40321–6) **[Reaction mechanism studies of heavy ion induced nuclear reactions]: Annual progress report.** Mignerey, A.C. Maryland Univ., College Park, MD (USA). Dept. of Chemistry and Biochemistry. Jan 1990. 31p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40321. Order Number DE90009985. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report contains papers that discuss: Target Dependence of Complex Fragment Emission in 47-MeV/u La-Induced Reactions; Deconvolution of Time-of-Flight Data to Improve Mass Identification; and Study of the Reaction of La + Al at E/A = 50 MeV with Landau-Vlasov Dynamics.

6515 Nuclear Properties and Reactions, A = 39-58, Experimental

29534 (GANIL-P–89-09) **Some properties of the β-delayed charged particle emission of ^{39} Tl and ^{40} Tl.** Lewitowicz, M. (Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen

(FR)); Detraz, C.; Anne, R.; Bricault, P.; Dufour, J.P.; Bazin, D.; Fleury, A.; Hubert, F.; Pravikoff, M.S.; Jacmart, J.C. Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France). 1989. 9p. Order Number DE90773449. Available from NTIS (US Sales Only), PC A02/MF A01.

Beta-delayed charged-particle radioactivity has been observed for the ^{40}Ti and ^{39}Ti isotopes produced by reactions of a 65 MeV/u ^{58}Ni beam on a natural Ni target. The measured half-lives for both nuclei are in agreement with theoretical predictions for β-decay. Partial decay scheme for ^{40}Ti is proposed. No evidence was found for direct two-proton radioactivity of ^{39}Ti..

6516 Nuclear Properties and Reactions, A = 59-89, Experimental

Refer also to citation(s) 29531, 29536

6517 Nuclear Properties and Reactions, A = 90-149, Experimental

Refer also to citation(s) 29531

29535 (KEK–89-13, pp. 74-79) **P and T violation in slow neutron scattering.** Masuda, Y. (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Oct 1989. (CONF-8903201–: 2. KEK symposium on ultracold neutrons (UCN) and fundamental physics with slow neutrons, Tsukuba (Japan), 11 Mar 1989). In *The 2nd KEK symposium on ultracold neutrons (UCN) and fundamental physics with slow neutrons.* Order Number DE90760025. Available from NTIS (US Sales Only), PC A07/MF A01.

Helicity dependence in the neutron radiative capture and the elastic scattering cross sections of ^{139}La was examined by a simultaneous measurement of capture γ-ray intensity and neutron transmission. Significant helicity dependence was only in a p-wave resonance of ^{139}La at E_n=0.734 eV. The longitudinal asymmetry in the p-wave resonance was $A_{L,\gamma}$=(9.5±0.3)% and $A_{L,n}$=(9.7±0.5)% for the capture γ-ray and the neutron transmission measurements, respectively. A possibility to measure T-odd correlations on polarized neutron transmission through a polarized lanthanum target is discussed. (author).

29536 **Angular momentum effects in subbarrier fusion.** Halbert, M.L. (Oak Ridge National Lab., TN (USA)); Beene, J.R.; Hensley, D.C.; Honkanen, K.; Semkow, T.M.; Abenante, V.; Sarantites, D.G.; Li, Z. pp. 541 of Proceedings of the 6th Adriatic international conference on nuclear physics: Frontiers of heavy-ion physics. Cindro, N.; Caplar, R.; Greinder, W. World Scientific Pub. Co., Teaneck, NJ (USA) (1987). DOE Contract AC05-84OR21400. (CONF-8706113–: 6. Adriatic international conference on nuclear physics: frontiers of heavy-ion physics, Dubrovnik (Yugoslavia), 15-19 Jun 1987).

The authors discuss angular-momentum distributions σ_I for the compound nucleus ^{164}Yb deduced from measurements of γ-ray multiplicity for all significant evaporation residues from fusion of ^{64}Ni and ^{100}Mo and ^{16}O + ^{148}Sm. At the lowest bombarding energies the σ_I extend to higher I values than do predictions that include coupling of the principal inelastic channels, even if the coupling strengths are increased to match the experimental excitation function. Likewise, σ_I from an energy-dependent real potential fitted to the excitation function fails to reproduce the experimental σ_I distribution. No effects attributed to superdeformation were observed.

6518 Nuclear Properties and Reactions, A = 150-189, Experimental

Refer also to citation(s) 29536

29537 (UJF–01/89) **Reduced probabilities of gamma transitions in even-even erbium isotopes (A=158-170) and isotones with N=94 (A=158-164) (as well).** Adam, J.; Honusek, M.; Wagner, V. Ceskoslovenska Akademie Ved, Rez (Czechoslovakia). Ustav Jaderne Fyziky. Jan 1989. 71p. Order Number DE90623952. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The reduced probabilities of the E2 intraband and interband transitions in even-even erbium isotopes (A=158 to 170) and N=94 isotones (A=158 to 164) are analyzed using perturbation theory. The mixing wave functions and different values of intrinsic quadrupole moments were taken into account of ground, beta- and gamma-vibrational states. (author). 18 figs., 16 tabs., 52 refs.

6519 Nuclear Properties and Reactions, A = 190-219, Experimental

Refer also to citation(s) 29533

29538 (BNL–44431) **AGS silicon gold collisions measured in the E-810 TPC [Time Projection Chamber].** Bonner, B.E.; Buchanan, J.A.; Chiou, C.N.; Clement, J.M.; Corcoran, M.D.; Kruk, J.W.; Miettinen, H.E.; Mutchler, G.S.; Nessi, M.; Nessi-Tedaldi, F. Brookhaven National Lab., Upton, NY (USA); Rice Univ., Houston, TX (USA); City Coll., New York, NY (USA); Johns Hopkins Univ., Baltimore, MD (USA). 26 Mar 1990. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016;AS05-81ER40032;AC02-83ER40107;AC02- (CONF-900331–2: Heavy ion physics at the alternating gradient synchrotron, Upton, NY (USA), 5-7 Mar 1990). Order Number DE90010015. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The tracking detector of AGS Experiment 810 is a three-piece Time Projection Chamber (TPC) intended to measure all charged tracks in the forward hemisphere of the nucleon-nucleon center of mass system, i.e. forward of an angle of about 20 degrees in the lab. Each module of the TPC contains twelve rows of short anode wires which give 3-D space points on each track, but no dE/dx information useable for particle identification. The TPC was operated in a beam of silicon ions at the end of June 1989 and this talk reports the results of analysis of the data taken with a thin gold target in that run. We have gathered a similar amount of data from thin copper and silicon targets, the analysis of which is in a less advanced state. The results of our investigation of the neutral strange particle decays appear in a separate contribution by Al Saulys. This paper presents the current state of the analysis of the charged tracks from the silicon gold collisions. 1 ref., 15 figs.

29539 (CONF-900450–2) **Superdeformation in the mercury nuclei.** Janssens, R.V.F. (Argonne National Lab., IL (USA)); Carpenter, M.P.; Fernandez, P.B.; Moore, E.F.; Ahmad, I.; Khoo, T.L.; Wolfs, F.L.H.; Drigert, M.W.; Ye, D.; Beard, K.B. Argonne National Lab., IL (USA). [1990]. 15p. Sponsored by U.S. DOE Energy Research; National Science Foundation. DOE Contract W-31109-ENG-38;AC07-76ID01570;FG02-87ER40346. Grant PHY88-02279. From Nuclear structure in the '90's; Oak Ridge, TN (USA); 23-27 Apr 1990. Order Number DE90010103. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We shall first summarize the present experimental situation concerning ^{192}Hg, the nucleus regarded as the analog of ^{152}Dy for this superdeformation (SD) region in that gaps are calculated to occur at large deformation for Z = 80 and N = 112. Proton and neutron excitations out of the ^{192}Hg core will then be reviewed with particular emphasis on ^{191}Hg and ^{193}Tl. The presentation will conclude with a brief discussion on limits of the SD region for neutron deficient Hg nuclei. 26 refs., 10 figs.

6520 Nuclear Properties and Reactions, A = 220 and Above, Experimental

Refer also to citation(s) 29516

29540 (CONF-900295–3) **Fission at sub-barrier energies.** Back, B.B. (Argonne National Lab., IL (USA)); Betts, R.R.; Fernandez, P.; Glagola, B.G.; Happ, T.; Henderson, D.; Ikezoe, H.; Benet, P. Argonne National Lab., IL (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 6. workshop on nuclear dynamics; Jackson Hole, WY (USA); 17-24 Feb 1990. Order Number DE90010127. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Fission fragment angular distributions have been measured for the reaction ^{16}O + ^{232}Th at beam energies of 78.2, 82.2, 86.6, and

100.6 MeV. In this experiment, it was possible to determine the relative contributions of fragments from both the fission decay of the ^{248}Cf compound nuclei, formed in complete fusion reactions between the target and the projectile, and the sequential fission decay of nuclei in the Th region, populated in inelastic scattering and/or transfer reactions on the Th target. This separation was made possible by using flight-time measurements. It was found that fragments from fission of ^{248}Cf showed a somewhat smaller angular anisotropy as compared with earlier measurements in which the sequential fission component was not excluded. The anisotropies found in the present experiment are, however, even with this correction, somewhat larger than expected on the basis of theoretical models. 11 refs., 4 figs.

29541 (CONF-900608–2) **Analysis of the ^{239}Pu neutron cross sections from 300 to 2000 eV.** Derrien, H.; de Saussure, G. Oak Ridge National Lab., TN (USA). [1990]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From American Nuclear Society annual meeting; Nashville, TN (USA); 10-15 Jun 1990. Order Number DE90004303. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A recent high-resolution measurement of the neutron fission cross section of ^{239}Pu has allowed the extension from 1 to 2 keV of a previously reported resonance analysis of the neutron cross sections, and an improvement of the previous analysis in the range 0.3 to 1 keV. This report analyzes this region. 8 refs., 1 fig., 2 tabs.

29542 (CONF-900608–6) **On the ENDF/B unresolved resonance region formalism representation for ^{239}Pu.** Ono, S. (Centro Tecnico Aerospacial, Sao Jose dos Campos, SP (Brazil). Inst. de Estudos Avancados); Paviotti-Corcuera, R.; Perez, R.B.; de Saussure, G. Oak Ridge National Lab., TN (USA). 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From American Nuclear Society annual meeting; Nashville, TN (USA); 10-15 Jun 1990. Order Number DE90005675. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The purpose of this work is to compare the performance of several cross-section evaluation files for the calculation of average cross sections in the unresolved resonance region and to test the validity of the ENDF/B methodology for the calculation of self-shielding factors in this region. The ^{239}Pu neutron cross sections were used for this comparison since a multilevel R-matrix analysis was available, which extended the resolved resonance region from its present ENDF/B limit of 300 eV up to 1 keV. 12 refs., 2 tabs.

29543 (INS–787) **On the stopped antiproton production of heavy hypernuclei.** Bando, H.; Zofka, J. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Nov 1989. 15p. Order Number DE90777710. Available from NTIS (US Sales Only), PC A03/MF A01.

Contributions of various processes in stopped p-bar annihilation populating bound hypernuclear states are estimated for Pb and U targets and compared with experiment. The lower limit is estimated for the effect of unusual ($B \geq 1$) annihilations. (author).

6530 Nuclear Theory

Refer also to citation(s) 29506, 29518, 29537, 29907

29544 (ANL-PHY–89/1) **Proceedings of a symposium on the occasion of the 40th anniversary of the nuclear shell model: Part 2, Poster papers.** Lee, T.S.H.; Wiringa, R.B. (eds.). Argonne National Lab., IL (USA). Physics Div. Mar 1990. 113p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. (CONF-890583–Pt.2: Symposium on the occasion of the 40th anniversary of the nuclear shell model, Argonne, IL (USA), 25-27 May 1989). Order Number DE90010252. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

This report contains papers on the following topics: excitation of 1p-1h stretched states with the (p,n) reaction as a test of shell-model calculations; on Z=64 shell closure and some high spin states of ^{149}Gd and ^{159}Ho; saturating interactions in ^{4}He with density dependence; are short-range correlations visible in very large-basis shell-model calculations?; recent and future applications of the shell model in the continuum; shell model truncation schemes for rotational nuclei; the particle-hole interaction and high-spin states near A-16; magnetic moment of doubly closed shell +1 nucleon nucleus ^{41}Sc(I^{π}=7/2^{-}); the new magic nucleus ^{96}Zr; comparing several boson mappings with the shell model; high spin band structures in ^{165}Lu; optical potential with two-nucleon correlations; generalized valley approximation applied to a schematic model of the monopole excitation; pair approximation in the nuclear shell model; and many-particle, many-hole deformed states.

29545 (BNL-NUREG–44453) **Secondary interactions in HIJET.** Longacre, R.S. Brookhaven National Lab., Upton, NY (USA). 2 Apr 1990. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016;AC02-83ER40107;AS05-81ER40032;AC02- (CONF-900331–5: Heavy ion physics at the alternating gradient synchrotron, Upton, NY (USA), 5-7 Mar 1990). Order Number DE90010122. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This talk deals with the investigation of secondary interactions in proton-nucleus and nucleus-nucleus collisions using the Monte Carlo event generator HIJET.

29546 **The nuclear shell model: Proceedings.** Lee, T.-S.H.; Wiringa, R.B. 321p. Elsevier Science Publishers B.V., Amsterdam, The Netherlands (1990). Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Symposium on the occasion of the 40th anniversary of the nuclear shell model; Argonne, IL (USA); 25-27 May 1989.

A symposium was held May 25–27, 1989, at Argonne National Laboratory to celebrate the fortieth anniversary of the nuclear shell model. The focus of the meeting was not on past glory, however, but on the current status and future directions of the shell model. The topics covered included modern large-basis set calculations, developments in interacting boson models, applications to collective modes and high-spin states, connections to mean-field theories, and the latest experimental evidence on shell structure. Considerable emphasis was placed on the role the shell model can play in studies of nucleon structure and quantum chromodynamics in the nucleus.

29547 (CONF-900181–3) **A comparison of the velocity spectra obtained with the Boltzmann and Boltzmann-Langevin equations.** Stryjewski, J. (Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France)); Ayik, S.; Belkacem, M.; Suraud, E. Tennessee Technological Univ., Cookeville, TN (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-89ER40530. From 18. international workshop of the gross properties of nuclei and nuclear excitations; Hirschegg (Austria); 15-20 Jan 1990. Order Number DE90009316. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The velocity spectra of Intermediate Mass Fragments produced in the reaction ^{12}C + ^{12}C at 30, 40, 50, and 60 MeV/A are studied using both the Boltzmann and the Boltzmann-Langevin approaches. We find that the velocity distribution obtained with the stochastic Boltzmann-Langevin equation is significantly different from that obtained with the standard (non-stochastic) Boltzmann equation. 7 refs., 1 fig.

29548 (CONF-9002112–1) **Kaon production in Landau-Vlasov calculations.** Belkacem, M. (Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France)); Stryjewski, J.; Suraud, E.; Ayik, S. Tennessee Technological Univ., Cookeville, TN (USA). [1990]. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-89ER40530. From 28. winter meeting on nuclear dynamics; Bormio (Italy); Feb 1990. Order Number DE90009315. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The cross section of the Kaon production for the ^{12}C + ^{12}C and ^{93}Nb + ^{93}Nb systems at very "low" bombarding energy ($\leq$500 MeV/A) is estimated using both the Boltzmann and the Boltzmann-Langevin approaches. We find very small cross sections at these energies, but those obtained using the stochastic Boltzmann equation are substantially larger than those obtained with the standard Boltzmann equation. 15 refs., 3 figs.

29549 (KFK–4655) **Applications of the maximum entropy principle in nuclear physics.** Froehner, F.H. Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Inst. fuer Neutronenphysik

und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Projekt Schneller Brueter. Jan 1990. 38p. (CONF-8909300–: 9. summer school on nuclear physics, neutron physics and nuclear energy conference, Varna (Bulgaria), 28 Sep - 7 oct 1989). Order Number DE90780367. Available from NTIS (US Sales Only), PC A03/MF A01.

cSoon after the advent of information theory the principle of maximum entropy was recognized as furnishing the missing rationale for the familiar rules of classical thermodynamics. More recently it has also been applied successfully in nuclear physics. As an elementary example we derive a physically meaningful macroscopic description of the spectrum of neutrons emitted in nuclear fission, and compare the well known result with accurate data on ^{252}Cf. A second example, derivation of an expression for resonance-averaged cross sections for nuclear reactions like scattering or fission, is less trivial. Entropy maximization, constrained by given transmission coefficients, yields probability distributions for the R- and S-matrix elements, from which average cross sections can be calculated. If constrained only by the range of the spectrum of compound-nuclear levels it produces the Gaussian Orthogonal Ensemble (GOE) of Hamiltonian matrices that again yields expressions for average cross sections. Both avenues give practically the same numbers in spite of the quite different cross section formulae. These results were employed in a new model-aided evaluation of the ^{238}U neutron cross sections in the unresolved resonance region. (orig.).

29550 (RCNP-P–106, pp. 52-56) **Tensor resolving power in d + p → ^{3}He + π^{0} reaction.** Tanifuji, M. (Hosei Univ., Tokyo (Japan)); Yazaki, K. Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

Published in summary form only. PROTON REACTIONS/deuterium target; PROTON REACTIONS/polarization-asymmetry ratio; POLARIZED TARGETS; HELIUM 3; PIONS NEUTRAL; THRESHOLD ENERGY; SCATTERING LENGTHS; PION-NUCLEON INTERACTIONS

29551 (RCNP-P–106, pp. 29-33) **Total cross section of n+^{6}Li and n+^{7}Li scattering by three-cluster formulation.** Fujiwara, Yoshikazu (Kyoto Univ. (Japan). Faculty of Science); Tang, Y.C. Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

The scattering and reaction cross sections for n+^{7}Li system are examined with a multiconfiguration and multichannel resonating-group calculation utilizing a three-cluster formulation for α+3N+N system. The incorporated channels are n+^{7}Li, n+^{7}Li*, t+^{5}He, and ^{4}H+α, where ^{7}Li* is the excited state of ^{7}Li having t+α structure with the relative orbital angular momentum l=3. The obtained energy spectrum of ^{8}Li has a very nice agreement with the R-matrix predictions by Knox and Lane. The total elastic cross section for n+^{7}Li scattering is overestimated by about 15-20 %. For the total reaction cross section, the present calculation yields only 50-60 % of the experimental value, which is a consistent conclusion with the previous result of the seven-nucleon system in terms of the similar model. (author).

29552 (RCNP-P–106, pp. 26-28) **Calculation of cluster expansion method, 2.** Sakai, W. (Akashi Technical Coll., Hyogo (Japan)). Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan). 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

A Cluster method calculation is applied to determine the energy and radius of the ^{6}Li Nuclei. One Boson Exchange force and α cluster model are employed. The effect of scalar meson, vector meson and pseudo scalar meson are separately calculated. The tendency of these effect are reasonable. (author).

29553 (RCNP-P–106, pp. 20-25) **Analysis of 0^{+}-states on ^{16}O nucleus with the 4α-model Faddeev-Yakubovsky equation.** Oryu, S. (Science Univ. of Tokyo, Noda, Chiba (Japan). Faculty of Science and Technology); Kamada, H.; Sekiguchi, H.; Nishino, T.; Sekine, H. Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

The numerical calculation of the 4-body Faddeev-Yakubovsky equation was done in the case of 4α-model of ^{16}O, and the low-lying 0^{+}-states including the ground state are investigated. The rank-one α-α separable potential which was given by Kukulin-Neudatchin, is adopted for 0^{+}, 2^{+}, and 4^{+} states. We adopted 0^{+}, 2^{+} and 4^{+} substates for ^{12}C which are so called [3+1] sub-states, and also 0^{+}, 2^{+} and 4^{+} states for ^{8}Be-^{8}Be or [2+2] sub-states are chosen. Then, 30 state-channels all together are coupled. We obtained five energy levels below the 3α threshold energy -17.9 MeV of the ^{12}C ground state calculated. However, three of them (-30.1MeV, -39.6MeV, and -61.6MeV) may be physical states, but two levels left (-82.4MeV and -194.5MeV) are spurious states. In order to compare them with the experimental spectra, one should take into account not only the Coulomb energy but also effects of the three-cluster force. (author).

29554 (RCNP-P–106, pp. 15-19) **3-α model and 3-body force.** Kamada, Hiroyuki (Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study); Oryu, Shinsho. Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

The 3-alpha model of ^{12}C-nucleus is investigated by using the 3-body Faddeev equation with the Pauli-correct separable alpha-alpha potential. In the low-lying energy spectra of ^{12}C-nucleus, there are characteristic states which contain the shell-model-like states, cluster-states and negative parity states. We obtain aculate energy levels of cluster-states, but shell-model-like-states is over bound. By introducing several types of 3-body forces, we study the role of 3-body force in the composite particle system like ^{12}C-nucleus. It is found that the symmetric or 2-Gaussian type is better to reproduce the energy level structure than the others. (author).

29555 (RCNP-P–106, pp. 153-157) **Deuteron breakup reaction by low energy neutron.** Takemiya, Toshinori (Kumamoto Univ. (Japan). Faculty of Science). Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

A general formulus for the deuteron breakup reaction by low energy neutron is derived from the Faddeev equation. The formulus is applied to the kinematically incomplete deuteron breakup reaction. (author).

29556 (RCNP-P–106, pp. 136-139) **Phenomenological separable N-^{12}C interaction with correct energy-dependence in positive and negative energy regions.** Miyagawa, Kazuya (Okayama Coll. of Science (Japan)); Koike, Yasuro. Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

Published in summary form only. CARBON 12 TARGET/nuclear potential; CARBON 12 TARGET/neutron reactions; DEUTERON REACTIONS; OPTICAL MODELS; COUPLED CHANNEL THEORY; S MATRIX; YAMAGUCHI POTENTIAL; PHASE SHIFT; DIFFERENTIAL CROSS SECTIONS;

POLARIZATION-ASYMMETRY RATIO; ELASTIC SCATTERING; ENERGY DEPENDENCE

29557 (RCNP-P–106, pp. 144-148) **Three-nucleon continuum state and three-body force.** Ishikawa, Souichi (Tohoku Univ., Sendai (Japan). Dept. of Physics). Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

We solved the three-nucleon Faddeev integral equations in the coordinate space for some realistic N-N potentials above the three-body breakup threshold. Some numerical tests are given. (author).

29558 (RCNP-P–106, pp. 131-135) **Three-body Lippmann-Schwinger equation without rearrangement channels.** Sawada, Tatsuro (Nara Women's Univ. (Japan). Dept. of Physics). Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

In the theory of three-body scattering, the triad of Lippmann-Schwinger (LS) equation introduced by Gloeckle (the so-called LS triad) is believed to be equivalent to the Faddeev equation (Conjecture A). It is also believed that, in the absence of rearrangement channels, the LS triad degrades to a single three-body LS equation so that the latter is sufficient to yield a unique solution (Conjecture B). Underlying Conjecture B is Conjecture A. In this note, we investigate what is involed in these conjectures and whether and how they can be correct. (author).

29559 (RCNP-P–106, pp. 128-130) **Validity of continuum discretized coupled channels.** Yahiro, Masanobu (Shimonoseki Univ. of Fisheries, Yamaguchi (Japan)). Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

The widely-used continuum discretized coupled channels (CDCC) method is discussed as an approximate calculations of three body systems. The validity of the discretization and the truncation of the breakup states is discussed. A set of coupled equations is presented for converting a CDCC solution into a full solution of the original Schroedinger equation. (author).

29560 (RCNP-P–106, pp. 122-127) **Coupled-rearrangement-channel variational method for three-nucleon bound states.** Kameyama, H. (Kyushu Univ., Fukuoka (Japan). Dept. of Physics); Kamimura, M. Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. Nov 1989. (In Japanese). (CONF-8905289–: Workshop on few-body systems, Ibaraki (Japan), 22-24 May 1989). In *Proceedings of the workshop on few-body systems.* Order Number DE90760000. Available from NTIS (US Sales Only), PC A08/MF A01.

The coupled-rearrangement-channel variational method with Gaussian-basis functions is applied to the ^{3}H and ^{3}He ground states. The binding energies, probabilities of the S, S′, P and D states and the S- and D-wave asymptotic normalization constants for ^{3}H and ^{3}He are calculated with a realistic two-nucleon potential, Argonne V14 potential, and the Tucson-Melbourne three-nucleon potential. For ^{3}He, the Coulomb potential is included nonperturbatively. These values are compared with the results of the Faddeev calculations. Convergence of the present results is seen at a much smaller number of the three-body channels than in the Faddeev calculations. This is because the interaction is truncated in the angular momentum space in the Faddeev calculations but the full interaction is taken in the present method. (author).

29561 Structures of exotic nuclei. Hamilton, J.H. pp. 541 of Proceedings of the 6th Adriatic international conference on nuclear physics: Frontiers of heavy-ion physics. Cindro, N.; Caplar, R.; Greinder, W. World Scientific Pub. Co., Teaneck, NJ (USA) (1987). (CONF-8706113–: 6. Adriatic international conference on nuclear physics: frontiers of heavy-ion physics, Dubrovnik (Yugoslavia), 15-19 Jun 1987).

Discoveries of many different types of nuclear shape coexistence are being found at both low and high excitation energies throughout the periodic table, as documented in recent reviews. Many new types of shape coexistence have been observed at low excitation energies, for examples bands on more than four different overlapping and coexisting shapes are observed in ^{185}Au, and competing triaxial and prolate shapes in ^{71}Se and ^{176}Pt. Discrete states in super-deformed bands with deformations $\beta_2 \sim 0.4$-0.6, coexisting with other shapes, have been seen to high spin up to $60\hbar$ in ^{152}Dy, ^{132}Ce and ^{135}Nd. Super-deformed nuclei with N and Z both around 38 and around Z = 38, N $\geq$ 60. These data led to the discovery of new shell gaps and magic numbers of 38 for N and Z and 60 for N but now for deformed shapes. Marked differences in structure are observed at spins of 6 to 20 in nuclei in this region, which differ by only two protons; for example, ^{68}Ge and ^{70}Se. The differences are thought to be related to the competing shell gaps in these nuclei.

29562 Close collisions between light nuclei-orbiting and fusion. Shapira, D. (Oak Ridge National Lab., TN (USA)); Shivakumar, B.; Harmon, B.A.; Ayik, S. pp. 541 of Proceedings of the 6th Adriatic international conference on nuclear physics: Frontiers of heavy-ion physics. Cindro, N.; Caplar, R.; Greinder, W. World Scientific Pub. Co., Teaneck, NJ (USA) (1987). DOE Contract AC05-84OR21400. (CONF-8706113–: 6. Adriatic international conference on nuclear physics: frontiers of heavy-ion physics, Dubrovnik (Yugoslavia), 15-19 Jun 1987).

According to the authors, studies of close collisions in which nuclear matter, energy and angular momentum undergo substantial rearrangement should enhance understanding of the nuclear many-body system and of the behavior of bulk nuclear matter. The results and models based on studies of such processes between heavy nuclei bear this out. The lighter nuclei, on which this study focuses, are unique in several respects: their binding energy per nucleon increases with mass number - therefore the amalgamation of two such nuclei produces a composite at high excitation energies even for relatively low bombarding energies, and their fission into two complex fragments is also severely restricted. In these light systems the Coulomb and centrifugal barriers attain comparable magnitude and both barriers can influence the outcome of the collision. The study of collisions between light nuclei affords the possibility of full identification of all the detected reaction products, with a modest effort. The authors present their data which demonstrates that in collisions the two nuclei first form a rotating dinuclear complex (DNC) which can breakup into two complex fragments (orbiting) or evolve into a compound nucleus.

29563 The influence of the neutron-proton interaction on nuclei near and at double subshell closure. Meyer, R.A. (Lawrence Livermore National Lab., CA (USA)). pp. 541 of Proceedings of the 6th Adriatic international conference on nuclear physics: Frontiers of heavy-ion physics. Cindro, N.; Caplar, R.; Greinder, W. World Scientific Pub. Co., Teaneck, NJ (USA) (1987). DOE Contract W-7405-ENG-48. (CONF-8706113–: 6. Adriatic international conference on nuclear physics: frontiers of heavy-ion physics, Dubrovnik (Yugoslavia), 15-19 Jun 1987).

Present studies of ^{96} Zr with a double subshell closure are reviewed along with studies of neighboring nuclei. Combination of information from these studies are shown to lead to several important new features. Among these are: dual subshell closure in $_{40}$ Zr nuclei at N = 56, backbending of the 1g-intruder band as low as spin 6, evidence for double octupole phonon states, dramatic alteration of the low energy structure of the N-59 isotones, and the need for a stronger neutron-proton interaction strength used in collective models. Extension of these properties are shown to account for anomolous states in $^{102-8}$ Pd and ^{146} Gd.

29564 Study of nuclei far from stability with exotic nuclear beams. Takahashi, N. (College of General Education, Osaka Univ., Toyonaka-Osaka, 560 (JP)). pp. 541 of Proceedings of the 6th Adriatic international conference on nuclear physics: Frontiers of heavy-ion physics. Cindro, N.; Caplar, R.; Greinder, W. World Scientific Pub. Co., Teaneck, NJ (USA) (1987). (CONF-8706113–: 6. Adriatic international conference on nuclear physics: frontiers of heavy-ion physics, Dubrovnik (Yugoslavia), 15-19 Jun 1987).

A variety of stable and unstable nuclei has been created as fragments in high-energy heavy-ion collisions. Determination of their nuclear radii from the measurement of interaction cross sections reveals appreciable differences between the root-mean-square radii ^{6}He-^{6}Li, ^{8}He-^{8}Li and ^{9}Li-^{9}Be and, on the other hand, the same radii of the pair of mirror nuclei ^{7}Li-^{7}Be. The large radii of the neutron-rich isotopes ^{6}He and ^{8}He suggest the existence of a thick neutron crust. Another use is described of exotic nuclear beams for detection of snowball in superfluid helium. The authors observed a new possibility of studying nuclear moments of exotic nuclei, using the freezing-out of their polarization in a form of snowballs. ^{6}He and ^{8}He and many other beta-active nuclei also serve for study of the transport phenomena related to impurity ions and thus basic interactions in condensed matter.

29565 Origin of complex fragments in intermediate energy heavy ion reactions. Moretto, L.G. (Lawrence Livermore National Lab., CA (USA)). pp. 541 of Proceedings of the 6th Adriatic international conference on nuclear physics: Frontiers of heavy-ion physics. Cindro, N.; Caplar, R.; Greinder, W. World Scientific Pub. Co., Teaneck, NJ (USA) (1987). DOE Contract AC03-76SF00098. (CONF-8706113–: 6. Adriatic international conference on nuclear physics: frontiers of heavy-ion physics, Dubrovnik (Yugoslavia), 15-19 Jun 1987).

Complex fragments observed in intermediate energy heavy ion reactions are shown to arise from the binary decay of a compound nucleus formed in a complete or incomplete fusion process.

29566 Mechanism of dissipation in heavy-ion reactions. Nix, J.R. (Los Alamos National Lab., NM (USA)); Sierk, A.J. pp. 541 of Proceedings of the 6th Adriatic international conference on nuclear physics: Frontiers of heavy-ion physics. Cindro, N.; Caplar, R.; Greinder, W. World Scientific Pub. Co., Teaneck, NJ (USA) (1987). (CONF-8706113–: 6. Adriatic international conference on nuclear physics: frontiers of heavy-ion physics, Dubrovnik (Yugoslavia), 15-19 Jun 1987).

The authors discuss a surface-plus-window mechanism for the conversion of nuclear collective energy into internal degrees of freedom at intermediate excitation energies. This novel dissipation mechanism, which results from the long mean free path of nucleons inside a nucleus, involves interactions of either one or two nucleons with the moving nuclear surface and also, for dumbbell-like shapes encountered in heavy-ion reactions and fission, the transfer of nucleons through the window separating the two portions of the system. To illustrate the effect of surface-plus-window heavy-ion reactions, the authors present dynamical calculations for values of the dissipation strength corresponding to 27% and 100% of the Swiatecki wall-formula value, as well as for no dissipation. In addition to dynamical thresholds for compound-nucleus formation in heavy-ion reactions, their new picture describes such other phenomena as experimental mean fission-fragment kinetic energies for the fission of nuclei throughout the periodic system, enhancement in neutron emission prior to fission, short scission-to-scission times on sequential ternary fission, widths of mass and charge distributions in deep-inelastic heavy-ion reactions, and widths of isoscalar giant quadrupole and giant octupole resonances.

29567 Energy separation of the doublet of intrinsic states at the ground state of ^{229}Th. Reich, C.W. (Idaho National Engineering Laboratory, EG&G Idaho, Incorporated, Idaho Falls, Idaho 83415 (US)); Helmer, R.G. *Physical Review Letters (USA)*, 64(3): 271-273 (15 Jan 1990). DOE Contract AC07-76ID01570.

It has been known from some time that the intrinsic state labeled by the asymptotic quantum numbers (3/2)$^{+}$[631] lies quite close (<0.1 keV) to the (5/2)$^{+}$[633] ground state of ^{229}Th. Using the energies of selected γ rays emitted following the α decay of ^{233}U, we have obtained a value of 1±4 eV for the energy separation of these two intrinsic states.

6540 Radiation and Shielding Physics

Refer also to citation(s) 28085, 28587, 28590, 28839, 28892, 28897, 28926, 28927, 29571

29568 (CONF-900608–8) **Fision product evaluations for ENDF/B-VI.** Wright, R.Q. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From American Nuclear Society annual meeting; Nashville, TN (USA); 10-15 Jun 1990. Order Number DE90006562. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Most of the ENDF/B-V fission-product evaluations were completed during the time period 1974–1980, and some of these were based on very limited experimental data. For short-lived fission products, there is still very little experimental data available because of the difficulty of obtaining these measurements. However, since 1980 a considerable amount of new experimental data have become available for stable and long-lived fission products. By utilizing the new data, significant improvements are now possible for some fission-product evaluations. The purpose of this paper is to report on 16 ENDF/B-VI evaluations that have been done at Oak Ridge National Laboratory (ORNL). The primary emphasis in this work has been placed on the resolved resonance region, but for some nuclides, new experimental data were also used to improve the evaluations for energies above the resolved resonance range.

29569 (INP–1345/AP) **"Ottawa Sand", "Royer Dolomite" and "Dunite Sand" as reference samples for the thermal neutron absorption cross-section.** Czubek, J.A.; Drozdowicz, K.; Gabanska, B.; Igielski, A.; Krynicka-Drozdowicz, E. Institute of Nuclear Physics, Cracow (Poland). Oct 1986. 44p. Order Number DE90623767. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The absorption cross-section measurements performed for the thermal neutrons on the three samples supplied by the International Atomic Energy Agency are reported. The absorption cross-section was measured using a method developed at the Institute of Nuclear Physics in Cracow (Poland). The method consists in the irradiation by a pulsed fast neutron beam of the system containing the investigated sample surrounded by an outer moderator. The decay constant of the thermal flux in the system is measured as a function of the thickness of the moderator. The absorption cross-section of the sample is obtained from combining the experimental results and the theoretical calculation. Few independent assays were performed for each sample. The average values of the mass absorption cross-section in 10^{-3} cm^{2}/g are: 2.45 ± 0.23 for the Ottawa Sand, 2.71 ± 0.42 and 1.93 ± 0.28 for the Royer Dolomite, and 3.72 ± 0.22 for the Dunite Sand (at the 95% confidence level). The paper contains individual results of the mass and linear absorption cross-sections and densities of the rocks for each assay. Some experimental details and intermediate results in consecutive assays are also included. 25 refs., 6 figs., 36 tabs. (author).

29570 (LA-UR–90-97-Rev.) **An analysis of the finite-differenced, even-parity discrete-ordinates equations in slab geometry.** Miller, W.F. Jr. Los Alamos National Lab., NM (USA). 31 Jan 1990. 6p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-900608–9-Rev.: American Nuclear Society annual meeting, Nashville, TN (USA), 10-15 Jun 1990). Order Number DE90006479. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Considerable effort has been expended in recent years in finding improved spatial differencing schemes for the neutron and radiation transport equations. Standard criteria used to select a candidate scheme are its order of spatial convergence for small mesh size and its positivity in the sense that positive solutions emerge from positive input data. More recently, it has become clear that truly robust schemes must behave well in diffusing regions and must be compatible with an effective iteration acceleration method. Recently, Morel and Larsen reported their work on a promising new method called the multiple balance method that has virtually all the desirable characteristics. Here we study a different approach to the problem by considering discrete-ordinates approximations to the even-parity transport equations. We analyze three spatial difference approaches: diamond differencing, cell-edge differencing, and cell-center differencing. For the case of isotropic scattering and sources, the latter two approaches are shown to be strictly positive, to be second-order accurate, to be compatible with derived diffusion synthetic acceleration methods, and to possess the necessary diffusion limits. Unlike previous work with the even-parity equation, we do not use finite elements or variational principles. 5 refs., 1 tab.

6550 Medical Physics

29571 (CONF-900679–1) **An improved technique for reading C-39 track etch neutron dosimeters.** Koch, P.N.; Sygitowicz, L.S. Reynolds Electrical and Engineering Co., Inc., Las Vegas, NV (USA). 1989. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC08-89NV10630. From 1990 Health Physics Society meeting; Anaheim, CA (USA); 24-28 Jun 1990. Order Number DE90003944. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A significantly improved technique for reading CR-39 track etch neutron dosimetry foils has been developed at the Health Physics Laboratory of Reynolds Electrical & Engineering Co., Inc., at the Nevada Test Site. This new technique, using reflected light for illumination, can be used to discriminate against most surface defects and improves the accuracy and precision of track etch foil analysis. 9 figs.

29572 (SAAS-Mitt–88-02) **Standard operational radiation protection instructions in applying radiographic equipment 2. edit.** Staatliches Amt fuer Atomsicherheit und Strahlenschutz, Berlin (German Democratic Republic). 1988. 23p. (In German). Order Number DE90624694. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

According to article 16(3) of the Ordinance on the Implementation of Atomic Safety and Radiation Protection of 11 October 1984, operational radiation protection instructions have to be worked out for each type of nuclear energy application. Based on the valid legal provisions of the GDR and on experience and knowledge gained in practice, the most important operational instructions and procedures for the operation of radiographic equipment were compiled. The example should enable the management to make the instructions directly applicable and, if necessary, to modify or supplement them.

29573 A logical framework for radiation protection standards for the public. Alexander, R.E. pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

In the past the protection of the public from radiation has been provided by various Federal and State government agencies in a relatively uncoordinated manner. The EPA, NRC, DOE, DOD, DOT, State agencies and others have established and enforced standards applicable within their mandated jurisdictions. The amount of attention that has been given in the adoption of these standards to the possibility that people could be exposed to multiple sources is considered by some to be inadequate. There has been a tendency to develop specific standards, well below 500 millirems per year, on the basis of cost-benefit analysis that consider only the source under study. Logic would seem to dictate that an acceptable level of collective risk would be established for public exposure to ionizing radiation susceptible to governmental controls, and that an appropriate fraction of this risk would then allocated to each contributing source. Nothing of this nature has happened yet, but the problem of exposure to multiple sources is receiving more attention. In consideration of the above problems, a Federal interagency committee has been formed under the lead of the EPA to prepare new Federal guidance for radiation protection of the public. Several meetings of this committe have been held, and discussions have indicated the need for a logical framework within which the committee's deliberations can proceed in a systematic manner. The balance of this paper is devoted to a framework of this nature that has been presented to the committee and is now under consideration.

29574 Experience with the application of radiation protection standards: A driving force. Selby, J.M. (Pacific Northwest Lab., Richland, WA (USA)); Swinth, K.L.; Vallario, E.J. pp. 355 of Population exposure from the nuclear fuel cycle. Proceeding. Alpen, E.L.; Chester, R.O.; Fisher, D.R. Gordon and Breach Science Publishers S.A., New York, NY (US) (1988). DOE Contract AC06-76RL01830. (CONF-8709104–: ANS/ORNL topical conference on population exposure from the nuclear fuel cycle, Oak Ridge, TN (USA), 14-18 Sep 1987).

The purposes of this paper are: (1) to identify the driving forces for the development of new standards within the radiation protection areas; (2) to characterize the process of developing such guidance; (3) to discuss problems with the application of guidance; and (4) to discuss experience in applying recommendations and standards to radiation protection. Efforts to improve performance in health physics measurements, including methods to determine the feasibility and applicability of standards are also described in paper.

6560 Condensed Matter Physics

Refer also to citation(s) 28223, 28430, 28494, 28521, 28524, 28559, 28563, 28566, 28567, 28569, 28570, 28614, 28750, 28921, 29027

29575 (CONF-900466–8) **Mechanical properties of carbon-implanted niobium.** Zinkle, S.J. (Oak Ridge National Lab., TN (USA)); Huang, J.S. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990. Order Number DE90009864. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Polycrystalline niobium specimens were implanted with either 200 keV carbon ions or a combination of 50, 100, and 200 keV carbon ions to peak concentrations of 0.6 to 50 at. %. Microindentation techniques were used to measure the hardness and elastic modulus of the implanted layer. Both the hardness (H) and modulus (E) showed dramatic increases due to the carbon implantation. The measured peak hardness and modulus following uniform implantation with 16 at. % C were 15× and 3× that of niobium, respectively, which is comparable to the literature values for NbC. The peak hardness and modulus for the implanted specimens were observed at an indent depth of ~40 nm, which is about one-eighth of the depth of the implanted carbon layer. The decrease in the indentation mechanical properties at deeper indent depths is due to the interaction of long-ranging strain fields underneath the indenter with the niobium substrate. 17 refs., 6 figs.

29576 (CONF-900684–2) **A weak formulation for phase-change problems with bulk movement due to unequal densities.** Alexiades, V. (Tennessee Univ., Knoxville, TN (USA). Dept. of Mathematics); Drake, J.B. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 5. international colloquium on free boundary problems: theory and applications; Montreal (Canada); 13-22 Jun 1990. Order Number DE90009398. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

When the densities of solid and liquid are different, a change of phase induces a volume change, forcing movement of the bulk phases. Conservation of total energy across the interface leads to a modified Stefan Condition, which contains a term cubic in the interfacial speed. We present a weak formulation for the conservation of mass, momentum and energy and study numerically a 1-phase, 1-dimensional example. 6 refs., 3 figs.

29577 (KEK–89-2, pp. 36-39) **Analysis of electron-stimulated desorption of H^+ from W(100) based on measured time of flight.** Ikeda, Etsuro (Gakushuin Univ., Tokyo (Japan). Faculty of Science); Suzuki, Toshiyuki; Arakawa, Ichiro. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). May 1989. (In Japanese). (CONF-8903187–: 7. meeting on ultra high vacuum techniques for accelerators and storage rings, Tsukuba (Japan), 27-28 Mar 1989). In *Proceedings of the 7th meeting on ultra high vacuum techniques for accelerators and storage rings.* Order Number DE90741445. Available from NTIS (US Sales Only), PC A11/MF A01.

When a solid is irradiated with electron beams, atoms and molecules are deported from its surface through a electronic stimulation process. This process is called electron-stimulated desorption. The authors have been engaged in research aimed at investigating the mechanism of this process for hydrogen atoms desorbed from a tungsten crystal surface in an effort to develop a method for analysis of hydrogen atoms adsorbed on a solid surface. In particular, the present study focuses on quantitative

analysis and state analysis of hydrogen atoms adsorbed on a surface on the basis of measurements of the energy, directional distribution and yield of hydrogen atoms desorbed by electronic stimulation. H^+ ions desorbed by electron simulation is detected by the flight time method, and a discussion is made of the angular distribution and dependence of the desorption yield on the temperature of the substrate. Results show that H^+ signals decreases with increasing substrate temperature. A slight number of H^+ ions is found to be desorbed by electron simulation even at 673K. The number of desorbed ions is largest in the direction perpendicular to the surface. The desorption energy does not largely depend on the angle. (N.K.).

29578 (NAC-AR-86-01, pp. 229-238) **Solid state and materials research: Solid state interactions in thin-film structures.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Thin-film systems which are of importance to the microelectronics industry are discussed. Basic aspects of silicon process technology, such as metallisation, oxidation, and doping, are being investigated. Ion-beams from the Van de Graaff accelerator are used for characterisation, while radioactive tracers provide information about interaction mechanisms. Extensive use is also made of electron microscopy to determine the microstructure of the materials being studied. 6 figs., 5 refs.

29579 (NAC-AR-86-01, pp. 239-243) **Solid state and materials research: Laser irradiation of solids.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

A high-powered, pulsed (30 ns) ruby laser is used to modify the surface and subsurface regions of materials by rapid melting and quenching (greater than 10^9 degrees C/sec). Heat-flow calculations and modelling are used to determine temperature profiles in the irradiated materials, from which melt depths, recrystallisation velocities and quench rates are determined. The research also includes laser annealing of ion-implanted damage, laser-assisted doping of semiconductors and the formation of glassy materials. 3 figs., 1 tab.

29580 (NAC-AR-86-01, pp. 244-245) **Solid state and materials research: Nuclear characterization of materials.** National Accelerator Centre, Faure (South Africa). 1986. In *Annual report June 1986.* Order Number DE90624865. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

Short note. SOLID STATE PHYSICS/rutherford scattering; ANTIREFLECTION COATINGS; DEPTH; DEUTERIUM; FLUORINE; HYDROGEN; LEAD; NAC CYCLOTRON; OXYGEN; PROGRESS REPORT; STOICHIOMETRY; SULFUR; SURFACES; THIN FILMS; YTTRIUM; ZINC

29581 (SAND-89-2918C) **Molecular dynamics simulations of short-range force systems on 1024-node hypercubes.** Plimpton, S.J. Sandia National Labs., Albuquerque, NM (USA). [1990]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004159-3: 5. distributed memory computing conference, Charleston, SC (USA), 9-12 Apr 1990). Order Number DE90009833. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Two parallel algorithms for classical molecular dynamics are presented. The first assigns each processor to a subset of particles; the second assigns each to a fixed region of 3d space. The algorithms are implemented on 1024-node hypercubes for problems characterized by short-range forces, diffusion (so that each particle's neighbors change in time), and problem size ranging from 250 to 10000 particles. Timings for the algorithms on the 1024-node NCUBE/ten and the newer NCUBE 2 hypercubes are given. The latter is found to be competitive with a CRAY-XMP, running an optimized serial algorithm. For smaller problems the NCUBE 2 and CRAY-XMP are roughly the same; for larger ones the NCUBE 2 (with 1024 nodes) is up to twice as fast. Parallel efficiencies of the algorithms and communication parameters for the two hypercubes are also examined. 8 refs., 2 figs., 1 tab.

29582 (UCRL-CR-103294) **Transient effects in Brillouin gain spectroscopy in solids.** Fairs, G.W. (SRI International, Menlo Park, CA (USA)); Jusinski, L.E.; Dyer, M.J.; Bischel, W.K.; Hickman, A.P. Lawrence Livermore National Lab., CA (USA); SRI International, Menlo Park, CA (USA). 7 Dec 1989. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90009476. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Transient effects on Brillouin gain spectroscopy in solids are examined. A method for accurate measurements of Brillouin peak gain coefficients and linewidths valid in the transient regime is described. Detailed measurements in crystals are presented. 1 refs., 2 figs.

29583 (UCRL-CR-103297) **Brillouin gain spectroscopy in glasses and crystals.** Faris, G.W. (SRI International, Menlo Park, CA (USA). Molecular Physics Lab.). Lawrence Livermore National Lab., CA (USA); SRI International, Menlo Park, CA (USA). Molecular Physics Lab. Dec 1989. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90009536. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Gain spectroscopy is a well established technique for the study of nonlinear scattering phenomena. Several capabilities of gain spectroscopy make the technique very powerful for frequency domain measurements of scattering processes. The use of gain spectroscopy is illustrated by the application of the technique to Brillouin measurements in solids. 21 refs., 2 figs.

29584 Nonequilibrium interface kinetics during rapid solidification. Aziz, M.J. (Harvard Univ., Cambridge, MA (USA). Div. of Applied Sciences). pp. 462 of Science and technology of rapidly quenched alloys. Tenhover, M.; Johnson, W.L.; Tanner, L.E. Materials Research Society, Pittsburgh, PA (USA) (1987). (CONF-861207--: Materials Research Society fall meeting, Boston, MA (USA), 1-5 Dec 1986).

The deviations form local equilibrium at a rapidly moving solid-liquid interface are well documented. The fraction of solute atoms in the liquid that joins the crystal during rapid solidification approaches unity and the interface temperature drops. Experimental and theoretical work on impurity incorporation and interfacial undercooling is reviewed. Past and future experiments to test the theories are discussed.

29585 Ion beam deposition of calcium hydroxyapatite. Barthell, B.L. (Los Alamos National Laboratory, Materials Science and Technology Div., Los Alamos, NM (US)); Archuleta, T.A.; Kossowsky, R. pp. 806 of Biomedical materials and devices. Hanker, J.S.; Giammara, B. L. Materials Research Society, Pittsburgh, PA (USA) (1989). (CONF-8711102--: Symposium on biomedical materials and devices, Boston, MA (USA), 30 Nov - 4 dec 1987).

Calcium hydroxyapatite has been sputtered on glass and Ti-6Al-4V substrates using a 1.5 kV argon ion beam. The films have been examined by X- ray diffraction analysis, energy dispersive spectroscopy, scanning electron microscopy, and adhesion testing. Results of this experimentation are presented.

29586 Spectral function of a hole in a Hubbard antiferromagnet. Trugman, S.A. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)). *Physical Review, B: Condensed Matter (USA),* 41(1): 892-895 (1 Jan 1990).

The Green's function $G(\mathbf{k},\omega)$ is calculated for a hole in a Hubbard antiferromagnet by a new nonperturbative, variational method for an infinite square lattice. The quasiparticle and excited-state wave functions show that the substantial structure in the "incoherent" spectrum is related to string states for large U. The strength of the quasiparticle pole and the anisotropic effective mass are obtained as a function of (U/t). The quasiparticle lifetime is infinite for most $\mathbf{k}$.

29587 Iterative approaches to electronic structure with augmented bases. Fernando, G.W. (Department of Physics, Brookhaven National Laboratory, Upton, New York 11973-6000 (US)). *Physical Review, B: Condensed Matter (USA),* 41(2): 903-906 (15 Jan 1990). DOE Contract AC02-76CH00016.

Combining (local) density-functional theory with molecular dynamics provides a first-principles method of studying melting, disorder, and other complex phenomena. However, there are various technical questions that have to be dealt with before such realistic attempts can be made with accurate electronic-structure calculations that use augmented bases. Here we discuss certain technical aspects of speeding up the electronic-structure codes to allow combined calculations of molecular dynamics. We present an iterative scheme to handle the generalized eigenvalue problem, discuss some aspects of these calculations where improvements are needed, and also show the equivalence of the implementations of the Cholesky decomposition and the Gram-Schmidt orthonormalization.

29588 Disorder, screening, and quantum Hall oscillations. Esfarjani, K. (Department of Physics and Astronomy—University of Delaware, Newark, Delaware 19716 (USA)); Glyde, H.R.; Sayakanit, V. *Physical Review, B: Condensed Matter (USA)*, 41(2): 1042-1053 (15 Jan 1990). DOE Contract FG02-84ER45082.

The density of states (DOS) of electrons in two-dimensional (2D) quantum wells and the broadening of Landau levels (LL's) is evaluated. The electrons are assumed to interact with screened, charged impurities located at random in the material. The random location of the impurities leads to a disordered environment seen by the electrons. The screening of the impurities by the 2D electron gas is evaluated in a simple Thomas-Fermi model which depends on the DOS at the Fermi surface, $n(E_F)$. The DOS and screening are evaluated iteratively at each magnetic field value. We find that the self-consistent evaluation of the DOS and screening leads to broadening of the LL's and $n(E_F)$ that oscillates with B. The oscillating LL widths and $n(E_F)$ are compared with the data of Heitmann *et al.*, Englert *et al.*, Wang *et al.*, and Smith *et al.* and reproduce all the observed values quite well. The chief adjustable parameter is the impurity concentration.

29589 Generalized embedded-atom format for semiconductors. Carlsson, A.E. (Department of Physics, Washington University, St. Louis, Missouri 63130-4899 (USA)); Fedders, P.A.; Myles, C.W. *Physical Review, B: Condensed Matter (USA)*, 41(2): 1247-1250 (15 Jan 1990). DOE Contract FG02-84ER45130.

A new type of total-energy functional for semiconductors is proposed, using a form based on an approximate quantum-mecahnical analysis. Two new types of terms are included: pair terms giving a matrix description of an atom's local environment, and cluster terms describing the ring topology. The scheme reproduces both the covalent and metallic behavior of semiconductor materials in the appropriate limits. A parametrized form of the scheme is applied to Si.

29590 Method of producing non-agglomerating submicron size particles. Bourne, R.S.; Eichman, C.C.; Welbon, W.W. To Dept. of Energy, Washington, DC. USA Patent 4872905/A/. 10 Oct 1989. Filed date 11 May 1988. USA Patent Application 7-192,555. Int. Cl. C23C 15/00. 8p.

This paper describes how submicron size particles are produced by using a sputtering process to deposit particles into a liquid. The liquid is processed to recover the particles therefrom, and the particles have sizes in the range of twenty to two hundred Angstroms. Either metallic or non-metallic particles can be produced, and the metallic particles can be used in metallic inks.

6561 Superconductivity

Refer also to citation(s) 28445, 28458, 28460, 28466, 28467, 28468, 28498, 28507, 28508, 28509, 28510, 28511, 28512, 28513, 28517, 28520, 28775, 28780, 28782, 28788

29591 (CONF-8810423–1) **Hyperfine interactions associated with iron substituted superconducting oxides.** Ellis, D.E. (Argonne National Lab., IL (USA)); Dunlap, B.D.; Saitovitch, E.B.; Azevedo, I.S.; Scorzelli, R.B.; Kimball, C.W. Argonne National Lab., IL (USA). Jun 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Latin American conference on the applications of the Moessbauer Effect; Rio de Janeiro (Brazil); 31 Oct - 4 nov 1988. Order Number DE90010411. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Theoretical and experimental Moessbauer spectroscopy studies have been made concerning charge and spin densities and magnetic hyperfine fields (H_{hf}) in iron-substituted superconducting oxides. Calculations were carried out in the self-consistent-field embedded cluster model using local density theory (SCF-Xα) with a variational atomic orbital basis. Spectral densities and changes in charge and spin density were monitored around neighboring Cu sites, as well as Fe impurity site, and $La_2Cu_{1-x}Fe_xO_4$ and $YBa_2Cu_{3-x}Fe_xO_{7-y}$ compounds. Moessbauer isomer shifts (IS), quadrupole splittings (QS) and H_{hf} are obtained by fitting multiline models to the observed spectra and are compared with SCF-Xα results for specific lattice sites. The influence of oxygen vacancies and partial oxygen disorder is modelled and compared with the experimental data on variable oxygen content and disorder. 10 refs., 3 tabs.

29592 Single- vs. multi-orbital theories of the cuprate superconductors: Exact results on finite lattices. Schuttler, H.B. (Center for Simulation Physics, Univ. of Georgia, Athens, GA (US)); Chen, C.X.; Fedro, A.J. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-31-109-ENG-38. Grant DMR-8913878. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors present a comparative exact diagonalization study of single- and three-orbital Hubbard models for cuprate superconductors in their respective strong-coupling limits. For the simplest case of the three-orbital model, their results indicate a close quantitative correspondence with the single-orbital model, both in the groundstate properties and in the low-energy excitation spectra.

29593 The phonon-plasmon mechanism of high T_c. Kresin, V.Z. (Lawrence Berkeley Lab., Berkeley CA (US)); Morawitz, H. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). Contract N-00014-86-F0015. (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

New results describing further developments of the phonon-plasmon mechanism of high T_c, proposed earlier by the authors, are discussed. According to their approach, high T_c in the oxides is due to the coexistence of strong electron-phonon coupling and the plasmon mechanism connected with the formation of the unusual low-lying acoustic plasmon branches of these layered systems. It is shown that the importance of the phonon-plasmon mechanism (PPM) is connected with uniquely small values of E_F and v_F. For the lattice dynamics they consider phonon anharmonicity and the effect of hybridization of acoustic and optical branches. In addition, the existence of double well potentials for certain modes is discussed. Both effects lead to strong electron-phonon coupling. They also comment on the isotope effect. The non-monotonic dependence of T_c on the carrier concentration is explained with their model. A method based on the special feature of electron loss spectroscopy is proposed, namely its temperature dependence, which allows the determination of the presence of the low frequency plasmon branch.

29594 Electron-phonon interactions in copper-oxides. Kim, J.H. (The James Franck Institute, The Univ. of Chicago, Chicago, Illinois (US)); Levin, K.; Wentzcovitch, R.; Auerbach, A. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718–: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The authors calculate electron-phonon coupling constants for the copper oxide planes using a renormalized band structure as well as a diagrammatic 1/N approach. The effects of infinitely strong

Coulomb repulsion lead to a dramatic reduction in the coupling. Phononic, polaronic and some charge transfer descriptions of the superconductivity seem unlikely in view of these results.

29595 A virial theorem and the method of simulated annealing in the Ginzburg-Landau theory. Doria, M.M. (Instituto de Fisica, Univ. de Sao Paulo, C.P. 20516, San Paulo, SP 01498 (BR)); Gubernatis, J.E.; Rainer, D. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

The method of simulated annealing is used to solve the Ginzburg-Landau equations numerically. The authors also derived a viral theorem for the Ginzburg-Landau theory which establishes a direct relation between the magnetic induction, the external magnetic field and the average kinetic and field energies. The theorem is extended to the presence of inhomogeneities as well. The magnetic properties of superconductors type II are obtained by means of this simulated annealing method and the viral theorem.

29596 Anisotropy in magnetic properties of high-T_c materials. Kogan, V.G. (Iowa State Univ., Ames Lab, Ames, IA (US)). pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

A brief review is given on recent results concerning equilibrium flux-line lattices, the field distribution within a cell of vortex lattices, the transverse magnetization and the anisotropy related torque. Current carrying properties of boundaries between misaligned anisotropic superconductors are discussed.

29597 High-resolution-angle resolved photoemission studies of high temperature superconductors. Olson, C.G. (Ames Lab, Iowa State Univ., Ames, IA (US)); Liu, R.; Lynch, D.W.; Veal, B.W.; Chang, Y.C.; Jiang, P.Z.; Liu, J.Z.; Paulikas, A.P.; List, R.S. pp. 1744 of Proceedings of the international conference on materials and mechanisms of superconductivity. High temperature superconductors II. Part 1-2. Shelton, R.N.; Harrison, W.A.; Phillips, N.E. Elsevier Science Pub. Co., Inc., New York, NY (USA) (1989). DOE Contract W-7405-ENG-82. Grant N00014-89-J-1837. (CONF-890718--: International conference on materials and mechanisms of superconductivity - high-temperature superconductors II, Stanford, CA (USA), 23-28 Jul 1989).

This paper presents recent photoemission studies of Y 123 and Bi 2212 performed with high energy and angular resolution. They provide detailed information on the nature of the states near the Fermi level. Measurements of the superconducting gap, band dispersion, and the density of states near the Fermi level in the normal state all support a Fermi liquid description of these materials.

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Refer also to citation(s) 29334, 29478, 29492

29598 (FNAL-TM-1647) **Repetitive Stern-Gerlach effect.** Hsueh, S.-Y. Fermi National Accelerator Lab., Batavia, IL (USA). 13 Mar 1990. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE90010163. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

I show that two spin rotators 180° apart may be desirable for the repetitive Stern-Gerlach effect. I also calculate the effect of depolarization resonance on the repetitive Stern-Gerlach effect. It is shown that to first order in resonance strength, we can avoid the imperfection resonance if the energy of the beam is at $G\gamma = n + 1/2$. The time available for accumulating the Stern-Gerlach kick is then limited by the intrinsic resonance. 5 refs., 1 fig.

29599 (HEPHY-PUB-525/89) **The relativistic virial theorem.** Lucha, W. (Oesterreichische Akademie der Wissenschaften, Vienna (Austria). Inst. fuer Hochenergiephysik); Schoeberl, F.F. Oesterreichische Akademie der Wissenschaften, Vienna (Austria). Inst. fuer Hochenergiephysik. Nov 1989. 6p. (UWThPh-1989-62). Order Number DE90623358. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The relativistic generalization of the quantum-mechanical virial theorem is derived and used to clarify the connection between the nonrelativistic and (semi-)relativistic treatment of bound states. 12 refs. (Authors).

29600 (JINR-E11-89-442) **On approximation of nonlinear boundary integral equations for the combined method.** Gregus, M.; Khoromsky, B.N.; Mazurkevich, G.E.; Zhidkov, E.P. Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation. 22 Sep 1989. 8p. Sponsored by Joint Institute for Nuclear Research. (CONF-890866-2: 11. international conference on boundary element methods in engineering (BEM-11), Boston, MA (USA), 29-31 Aug 1989). Order Number DE90009784. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; JINR, Publishing Dept., Head Post Office, P.O. Box 79 101000, Moscow, USSR.

The nonlinear boundary integral equations that arise in research of nonlinear magnetostatic problems are investigated in combined formulation on an unbounded domain. Approximations of the derived operator equations are studied based on the Galerkin method. The investigated boundary operators are strongly monotone, Lipschitz-continuous, potential and have a symmetrical Gateaux derivative. The error estimates of the Galerkin's approximation in Sobolev spaces of fractional powers are obtained using the above-mentioned properties of the operators, too. The problem has been studied on surfaces in two and three-dimensional spaces. We answer also some questions on convergence connected with the discretized systems of equations. 21 refs.

29601 (N-90-16401) **Triangle based TVD schemes for hyperbolic conservation laws. Final report.** Durlofsky, L.J.; Osher, S.; Engquist, B. National Aeronautics and Space Administration, Hampton, VA (USA). Inst. for Computer Applications in Science and Engineering. Jan 1990. 31p. (NASA-CR-181984;NAS-1.26:181984;ICASE-90-10). Available from NTIS, PC A03/MF A01.

A triangle based total variation diminishing (TVD) scheme for the numerical approximation of hyperbolic conservation laws in two space dimensions is constructed. The novelty of the scheme lies in the nature of the preprocessing of the cell averaged data, which is accomplished via a nearest neighbor linear interpolation followed by a slope limiting procedures. Two such limiting procedures are suggested. The resulting method is considerably more simple than other triangle based non-oscillatory approximations which, like this scheme, approximate the flux up to second order accuracy. Numerical results for linear advection and Burgers' equation are presented.

29602 (UCRL-102992) **Singularity spectra of the free running thermal blooming (STRS) instability.** Viecelli, J.A. Lawrence Livermore National Lab., CA (USA). 7 Feb 1990. 4p. Sponsored by Optical Society of America. DOE Contract W-7405-ENG-48. (CONF-9006137-1: Nonlinear dynamics in optical systems topical meeting, Afton, OK (USA), 4-8 Jun 1990). Order Number DE90008723. Available from NTIS, PC A; GPO Dep.

Computations of the $f(\alpha)$-spectrum of the saturated optical intensity pattern produced by small scale thermal blooming show that the irradiance does not follow a log-normal distribution. 3 refs., 1 fig., 1 tab.

29603 (UCRL-ID-103207) **Liouville equation in the presence of non-colinear light beams.** Sacks, R.; Shore, B.; Hermann, M.; Dixit, S. Lawrence Livermore National Lab., CA (USA). 28 Feb 1990. 8p. Sponsored by U.S. Department of Defense; U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010231. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Explicitly solving the Liouville equation for a Raman active medium on a spatial grid sufficiently fine to represent significant

non-paraxial content to the pump beam can be prohibitively expensive. We develop a method for representing the light as small angle cones about a set of discrete propagation angles, and extracting a polarization field which is consistent with that representation. 1 ref.

29604 (UWThPh–1989-47) **On nodes of local solutions to Schroedinger equations.** Hoffmann-Ostenhof, M.; Hoffmann-Ostenhof, T. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 6p. Order Number DE90623376. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

It is shown that the local properties of the wave-function in the neighbourhood of a zero are determined to a certain extent by global properties of the nodal set of the corresponding surface harmonic. 8 refs.

29605 (UWThPh–1989-49) **Constraints, BRST-Cohomology and stochastic quantization.** Hueffel, H. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 6p. Order Number DE90623377. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

After presenting a pedagogical introduction to the Becchi-Rouet-Stora-formalism we introduce stochastic quantization in extended configuration space. The appearance of a specific projection operator and its relationship to the BRST-cohomology is pointed out. 20 refs. (Author).

29606 (UWThPh–1989-51) **K-automorphisms in quantum theory.** Narnhofer, H. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 10p. Order Number DE90623378. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Two possibilities to define quantum K-systems are offered and their consequences are compared. Examples are given and open problems are pointed out. 21 refs. (Author).

29607 (UWThPh–1989-52) **Algebraic topological entropy.** Hudetz, T. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 15p. Order Number DE90623379. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

As a 'by-product' of the Connes-Narnhofer-Thirring theory of dynamical entropy for (originally non-Abelian) nuclear C^*-algebras, the well-known variational principle for topological entropy is eqivalently reformulated in purly algebraically defined terms for (separable) Abelian C^*-algebras. This 'algebraic variational principle' should not only nicely illustrate the 'feed-back' of methods developed for quantum dynamical systems to the classical theory, but it could also be proved directly by 'algebraic' methods and could thus further simplify the original proof of the variational principle (at least 'in principle'). 23 refs. (Author).

29608 (UWThPh–1989-56) **Lightlike contractions.** Aichelburg, P.C. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 8p. Order Number DE90623388. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The technique of lightlike contractions in flat and curved space is described. The method consists in boosting a classical field configuration to the velocity of light by an appropriate generalized Lorentz transformation. Within this framework the gravitational field of a massless neutral particle is a meaningful concept. For electrically charged particles, however, the field equations seem to prevent an analogous procedure. We thus conjecture that general relativity forbids the existence of charged point particles moving with the velocity of light. 6 refs. (Author).

29609 (UWThPh–1989-59) **Solved and unsolved problems in the stochastic quantization of gravity.** Rumpf, H. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 15p. Order Number DE90623389. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The stochastic quantization method of Parisi and Wu (1981) is generalized into a covariant version in order to render it applicable to Einstein's General Relativity Theory. 22 refs.

29610 (UWThPh–1989-68) **Electric dipole moments reconsidered.** Rupertsberger, H. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 10p. Order Number DE90623380. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The electric dipole moments of elementary particles, atoms, molecules and their connection to the electric susceptibility are discussed for stationary states. Assuming rotational invariance it is emphasized that for such states only in the case of a parity and time reversal violating interaction the considered particles can obtain a nonvanishing expectation value for the electric dipole moment. 1 fig., 13 refs. (Author).

29611 (UWThPh–1989-70) **A model for a dia-electric.** Narnhofer, H.; Thirring, W. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 3p. Order Number DE90623381. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Andre Martin is the master of the Schroedinger equation. Where others may do with cheap approximations he would not buy anything but a conclusive result proved by hard analysis. In recent years he applied his skill to meson spectroscopy where one deals with confining potentials. As a birthday present we will offer him a charged medium which gives such a potential purely in the framework of electrodynamics. We realize that this is just a toy and not the mechanism realized in nature. There it is supposed to emerge from QCD where also nonlinear and quantum effects are important. But our model may provide a formal basis to the heuristic discussions one finds in textbooks [1,2]. 6 refs. (Author).

29612 (UWThPh–1989-75) **On the local behaviour of nodes of solutions of Schroedinger equations in dimensions $\geq$ 3.** Hoffmann-Ostenhof, M. (Vienna Univ. (Austria). Inst. fuer Theoretische Physik); Hoffmann-Ostenhof, T. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 1989. 17p. Order Number DE90623382. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The behaviour of local solutions of the Schroedinger equation in the neighbourhood of a zero is investigated. 14 refs.

29613 (UWThPh–1990-1) **Perturbations of supersymmetric systems in quantum mechanics.** Baumgartner, B. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 30 Jan 1990. 15p. Order Number DE90623390. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The methods of supersymmetry are extended to the factorization method. The degeneracy of levels in factorizable systems is broken under perturbations. With the methods of supersymmetry it is possible to state laws on the order of these perturbed energy levels. One proof of a confirmation of these laws has a more algebraic touch and works for first order perturbation theory. The proof of the laws beyond perturbation theory is hard, more of an analytic spirit and exploits convexity properties of the potentials. The convexity properties serve also for an intuitive argument. An important application is the law on the ordering of energy levels in atoms. 8 refs. (Author).

29614 (UWThPh–1990-5) **Gauge fixing by choosing a metric in the BRST phase space.** Hueffel, H. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 6 Feb 1990. 7p. Order Number DE90623383. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Within the framework of Becchi-Rouet-Stora stochastic quantization we show that the choice of a metric in the BRST phase space is related to the conventional gauge fixing procedure. 6 refs. (Author).

29615 (UWThPh–1990-7) **Bounds on the order of vanishing of eigenfunctions of Schroedinger operators.** Hoffmann-Ostenhof, M. (Vienna Univ. (Austria). Inst. fuer Theoretische Physik); Hoffmann-Ostenhof, T. Vienna Univ. (Austria). Inst. fuer Theoretische Physik. 21 Feb 1990. 16p. Order Number DE90623384. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

We study L^2-solutions of $(-\Delta+V-E)\psi = 0$ in R^n, $n \geq 2$ and derive a sharp upper bound to $l_{x_0}(\psi)$ in terms of x_0, E and V under rather restrictive assumptions on V. We show for V smooth that an upper bound to $l_{x_0}(\psi)$ implies an upper bound to the dimension of the eigenspace associated to E. 16 refs. (Authors).

29616 **A boundary integral approach to unstable solidification.** Strain, J. (Lawrence Berkeley Laboratory, Berkeley, California (USA)). *Journal of Computational Physics (USA),* 85(2): 342-389 (Dec 1989). DOE Contract AC03-76SF00098.

We consider the supercooled Stefan problem with a general anisotropic curvature- and velocity-dependent boundary condition on the moving interface. We present numerical methods, based on an integral equation formulation and including a new algorithm for moving curves with curvature-dependent velocity. These methods compute a periodic interface with $O(\Delta t)$ accuracy, where Δt is the time step. Previous work has been limited to short time spans and achieved slightly less than $O(\Delta t^{1/2})$ accuracy. Accurate numerical results are seen to agree with the predictions of linear stability theory. This agreement has eluded previous authors, because their numerical methods suffered from grid effects and their linear stability theory was incorrect. We study the long-time evolution of an unstable interface. Our computations exhibit the beginnings of a sidebranching instability when the boundary condition includes anisotropy and tip-splitting in the isotropic case. © 1989 Academic Press, Inc.

29617 Multifractal properties of snapshot attractors of random maps. Romeiras, F.J. (Laboratory for Plasma Research, University of Maryland, College Park, Maryland 20742 (USA)— Centro de Electrodinamica (INIC), Instituto Superior Tecnico, 1096 Lisboa Codex, (Portugal)); Grebogi, C.; Ott, E. *Physical Review, A (General Physics) (USA),* 41(2): 784-799 (15 Jan 1990).

We consider qualitative and quantitative properties of "snapshot attractors" of random maps. By a random map we mean that the parameters that occur in the map vary randomly from iteration to iteration according to some probability distribution. By a "snapshot attractor" we mean the measure resulting from many iterations of a *cloud* of initial conditions viewed at a *single* instant (i.e., iteration). In this paper we investigate the multifractal properties of these snapshot attractors. In particular, we use the Lyapunov number partition function method to calculate the spectra of generalized dimensions and of scaling indices for these attractors; special attention is devoted to the numerical implementation of the method and the evaluation of statistical errors due to the finite number of sample orbits. This work was motivated by problems in the convection of particles by chaotic fluid flows.

29618 One-dimensional nonlinear Schroedinger equation: A nonlinear dynamical approach. Wan, Y. (Ames Laboratory and Department of Physics—Iowa State University, Ames, Iowa 50011 (USA)); Soukoulis, C.M. *Physical Review, A (General Physics) (USA),* 41(2): 800-809 (15 Jan 1990). DOE Contract W-7405-ENG-82.

We have studied a time-independent nonlinear Schroedinger equation of the tight-binding form on a one-dimensional lattice. The real and complex wave functions as solutions to the equation are considered separately for different physical problems. For each case, an area-preserving map for the discrete nonlinear Schroedinger equation is introduced and analyzed. The bounded solutions can be organized in hierarchies composed of periodic, quasiperiodic, as well as chaotic orbits on the phase plane of the nonlinear map. A "stability-zone" diagram, where the bounded orbits exist, is displayed in the parameter space, serving as "phase diagram" of the nonlinear Schroedinger equation under appropriate boundary conditions. Studies of the stability zone yield useful information for the physical problems considered. The periodic orbits and their stabilities can be obtained by a convergent perturbation method. Finally, we remark on several physical problems where these results might be applicable. In particular, we discuss the stabilities of the large polaron solution in the Holstein model.

29619 Conductivity tensor of anisotropic composite media from the microstructure. Torquato, S. (Department of Mechanical and Aerospace Engineering—Department of Chemical Engineering, North Carolina State University, Raleigh, North Carolina 27695-7910 (US)); Sen, A.K. *Journal of Applied Physics (USA),* 67(3): 1145-1155 (1 Feb 1990). DOE Contract FG05-89ER45384.

Perturbation expansions and rigorous bounds on the effective conductivity tensor σ_e of d-dimensional anisotropic two-phase composite media of arbitrary topology have recently been shown by the authors to depend upon the set of n-point probability functions $S^{(i)}_1,\ldots, S^{(i)}_n$. $S^{(i)}_n$ gives the probability of simultaneously finding n points in phase i (i=1,2). Here we describe a means of representing these statistical quantities for distributions of identical, oriented inclusions of arbitrary shape. Our results are applied by computing second-order perturbation expansions and bounds for a certain distribution of oriented cylinders with a finite aspect ratio. We examine both cases of conducting cylindrical inclusions in an insulating matrix and of insulating *cracks* or *voids* in a conducting matrix.

29620 Generalized Brownian dynamics. II. Vibrational relaxation of diatomic molecules in solution. Smith, D.E. (Department of Chemistry, University of California, Berkeley, California 94720 (US)— Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, Berkeley, California 94720 (US)); Harris, C.B. *Journal of Chemical Physics (USA),* 92(2): 1312-1319 (15 Jan 1990).

A simple classical stochastic model for diatomic vibrational relaxation, based on the generalized Langevin equation, is presented. The memory function in the generalized Langevin equation is determined directly from equilibrium force autocorrelation functions for the individual atoms of the diatomic dissolved in the solvent of interest. A simple autoregressive (AR) procedure, developed in a preceding paper [D. E. Smith and C. B. Harris, J. Chem. Phys. **92**, 1304 (1990)], is used for modeling the memory functions to arbitrary order. This model is tested on the system of iodine in Lennard–Jones xenon using fourth order AR approximations for the memory functions, and is found to be very effective in reproducing data from molecular dynamics simulations at two very different densities. Results are discussed in terms of the simplifying assumption that the solvent interaction with the diatomic can be characterized by equilibrium dynamics of single atoms in solution.

29621 Generalized Brownian dynamics. I. Numerical integration of the generalized Langevin equation through autoregressive modeling of the memory function. Smith, D.E. (Department of Chemistry, University of California, Berkeley, California 94720 (US)— Materials and Chemical Sciences Division, Lawrence Berkeley Laboratory, Berkeley, California 94720); Harris, C.B. *Journal of Chemical Physics (USA),* 92(2): 1304-1311 (15 Jan 1990).

A method is presented for numerical integration of the generalized Langevin equation (GLE) based on modeling of the "random force" as a discrete autoregressive process. This modeling procedure, drawn from digital signal processing and spectral estimation methods which have been used extensively in electrical engineering applications, provides for efficient evaluation of the friction integral in the GLE as well as for generation of a random force process with the desired spectrum. The method is shown, through comparison with molecular dynamics results, to be effective in simulating the force autocorrelation function of an iodine atom dissolved in Lennard-Jones (LJ) xenon. In a companion paper this method is applied in a simulation of the vibrational relaxation of I_2 in LJ xenon at two very different densities and found to perform well.

70 FUSION ENERGY

29622 (IPPCZ–293/I) **15th Czechoslovak seminar on plasma physics and technology. Part 1.** Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. 159p. (In English, Russian). (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Of the 17 papers contained in the proceedings, 8 papers deal with various technological applications of a low-temperature plasma, e.g., the synthesis of very high-purity materials and ultrafine powders, plasma polymerization, and plasma deposition of composite superconducting films. Two papers review the activity in the field of mathematical modeling and experimental investigation of electric arcs used in industrial and laboratory plasmatrons. Other papers report the results of varous diagnostic methods (IR and optical spectroscopy, CARS spectroscopy, probes and interferometry) applied to low-temperature laboratory and technological plasmas. In one paper the positive streamer phenomenon in electric discharges is discussed. (J.U.).

7001 Plasma Research

Refer also to citation(s) 28842, 28881, 28937, 29339, 29792, 29793, 29801, 29817, 29824, 29827, 29828, 29831, 29835, 29837, 29839, 29840, 29841

29623 (CONF-900557–1) **The ATF two-frequency correlation reflectometer.** Hanson, G.R.; Wilgen, J.B.; Anabitarte, E.; Bell, J.D.; Harris, J.H.; Dunlap, J.L.; Thomas, C.E. Oak Ridge National Lab., TN (USA). [1990]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 8. topical conference on high-temperature plasma diagnostics; Hyannis, MA (USA); 6-10 May 1990. Order Number DE90010434. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Advanced Toroidal Facility (ATF) density fluctuation reflectometer system consists of two individual reflectometers operating in the 30- to 40-GHz band. Each reflectometer consists of a tunable microwave source and a quadrature phase detector connected to the same antenna system. This arrangement allows two-frequency operation along the same radial chord for radial coherence measurements. The technique used in making radial coherence measurements is discussed and the results of such experiments are given. Initial experiments have shown high coherence when the frequencies of the two reflectometers are tuned close together and a clear loss of coherence as the radial separation of the cutoff layers is increased by increasing the frequency separation of the two reflectometers. Recent results have shown that local measurements of density fluctuations in plasmas with electron cyclotron heating (ECH) are possible and that detailed structure can be seen in the fluctuation spectra. In addition, radial correlation lengths have been found to be from 0.5 to 1.0 cm in ECH plasmas, with some frequency structures having correlation lengths up to 3 cm. In plasmas with neutral beam injection (NBI), the radial correlation lengths in the edge region have been found to be approximately 0.1–0.2 cm. 4 figs.

29624 (CONF-900602–1) **Density fluctuation measurements on the ATF [Advanced Toroidal Facility] using a two-frequency reflectometer.** Anabitarte, E. (Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas, Madrid (Spain). Inst. de Energias Renovables); Hanson, G.R.; Harris, J.H.; Wilgen, J.B.; Bell, J.D.; Dunlap, J.L.; Hidalgo, C.; Thomas, C.E.; Uckan, T. Oak Ridge National Lab., TN (USA). [1990]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 17. European conference on controlled fusion and plasma heating; Amsterdam (Netherlands); 25-29 Jun 1990. Order Number DE90009810. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A microwave reflectometer system has been installed and operated on the Advanced Toroidal Facility (ATF) to measure density fluctuations. This system consists of two individual reflectometers that use the same antenna system and operate in the 30- to 40-GHz band. This arrangement allows operation at two frequencies along the same radial chord so that radial coherence measurements are possible. During the initial operating period of the reflectometer, a correlation was observed between a change in the edge density fluctuation spectrum and a transition to improved confinement. Recently, local measurements of the density fluctuation spectra in electron-cyclotron-heated (ECH) plasmas has been shown to agree with Langmuir probe measurements at the edge. Furthermore, structure in the spectra has been observed in some ECH plasmas. 4 refs., 3 figs.

29625 (CONF-900602–3) **Impurity transport in ATF [Advanced Toroidal Facility] and the effect of controlled impurity injection.** Horton, L.D. (Oak Ridge National Lab., TN (USA)); Isler, R.C.; Crume, E.C. Jr.; Jernigan, T.C.; Morita, S. Oak Ridge National Lab., TN (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 17. European conference on controlled fusion and plasma heating; Amsterdam (Netherlands); 25-29 Jun 1990. Order Number DE90009826. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The operating window in the Advanced Toroidal Facility (ATF) is limited by the occurrence of a sudden decrease in energy confinement. Although it is clear that the final loss of confinement is due to thermal instability at low temperature, the cause of the initial degradation that reduces the plasma temperature to this low range is not clear. A series of experiments using impurities injected either by a fast gas puffing system or by a laser ablation system has been carried out to study the role of impurities in initiating these collapses of energy confinement. For the experiments described here the injected impurities were aluminum and scandium.

29626 (CONF-900602–5) **Bootstrap current studies in the Advanced Toroidal Facility.** Murakami, M.; Carreras, B.A.; Bigelow, T.S.; Dyer, G.R.; England, A.C.; Glowienka, J.C.; Hiroe, S.; Howe, H.C.; Jernigan, T.C.; Rasmussen, D.A. Oak Ridge National Lab., TN (USA); National Inst. for Fusion Science, Nagoya (Japan); Georgia Inst. of Tech., Atlanta, GA (USA). [1990]. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 17. European conference on controlled fusion and plasma heating; Amsterdam (Netherlands); 25-29 Jun 1990. Order Number DE90009859. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The toroidal current observed during electron cyclotron heating (ECH) in the Advanced Toroidal Facility (ATF) torsatron is identified as bootstrap current. The observed current ranges between +3 kA and −1 kA with negligible Ohmic heating (OH) and ECH-driven currents. The observed currents agree well with predictions of neoclassical theory in magnitude (to within 30%) and parametric dependence (including the reversal of the current), as determined by systematic scans of quadrupole (shaping) and dipole (vacuum axis shift) moments of the vertical field. These results show that the current flow in ATF is well described by the neoclassical theory of bootstrap current despite the presence of anomalies in particle and heat flows. In addition, the results demonstrate the ability to control the toroidal current with the vertical field for currentless operation in stellarators. 5 refs., 5 figs.

29627 (CTH-IEFT/PP–1988-19) **Dissipative trapped electron effects on toroidal η_i-mode stability.** Jarmen, A. Chalmers Univ. of Tech., Goeteborg (Sweden). Inst. for Electromagnetic Field Theory and Plasma Physics. 1988. 31p. Order Number DE90623626. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A quadratic dispersion relation is derived for ion temperature gradient driven modes in toroidal geometry without any expansion in inverse aspect ratio and including the effect of dissipative trapped electrons. It is shown that for finite trapping the η_i-mode stability thresholds are discontinously shifted compared to the case without trapping. Furthermore the thresholds are not sensitive to the magnitude of the trapping. A stability requirement on the density scale length L_n which has to be larger than about half the major radius R and an upper and a lower η_i stability threshold which grow linearly with $\pm 2L_n/R$ are derived. (orig.).

29628 (DOE/ET/53088–424) **Wave-particle power transfer in a steady-state driven system.** Berk, H.L.; Breizman, B.N.; Hamaguchi, S. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Mar 1990. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–424). Order Number DE90010031. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The general expression of the power transfer from a high-energy ion beam to a background electrostatic plasma wave is obtained as a function of an arbitrary wave amplitude. The injection ions are assumed to slow down through classical transport processes and form a weakly destabilizing distribution function. It is verified that phase space gradients produced by a finite amplitude wave enhances the power transfer significantly, as was also indicated in earlier work. 4 refs., 3 figs.

29629 (DOE/ET/53088–426) **Resonant MHD modes with toroidal coupling: Part 1, Tearing modes.** Connor, J.W. (UKAEA Culham Lab., Abingdon (UK)); Hastie, R.J.; Taylor, J.B. Texas Univ., Austin, TX (USA). Inst. for Fusion Studies. Mar 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-80ET53088. (IFSR–426). Order Number DE90010077. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In a cylindrical plasma, tearing modes can be calculated by asymptotic matching of ideal mhd solutions across a critical layer. This requires a quantity Δ' which represents the 'discontinuity' in the ideal solution across the layer. In a torus, poloidal harmonics

are coupled and there are many critical surfaces for each toroidal mode number, and correspondingly many discontinuities Δ'_m. The ideal mhd solutions do not determine the Δ'_m but only a relation between them–described by an "E-matrix." We discuss the calculation of the E-matrix for a large aspect-ratio tokamak. In a weak-coupling approximation it is tri-diagonal and can be computed from integrals over the uncoupled eigenfunctions or from simple "basis-functions" comprising triplets of coupled poloidal harmonics. This weak coupling approximation fails if Δ'_m is already small for an uncoupled harmonic. An alternative strong-coupling approximation is developed for this case. 9 refs.

29630 (GA-A–20024) **Three-dimensional simulations of simple electron drift wave turbulence in tokamak geometry.** Waltz, R.E. General Atomics Co., San Diego, CA (USA). Mar 1990. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-89ER53277. (CONF-900237–1: Conference on research trends in nonlinear and relativistic plasma physics, San Diego, CA (USA), 2-8 Feb 1990). Order Number DE90009581. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A three-dimensional code is used to study the scaling of an electrostatic electron drift wave turbulence with respect to shear and curvature of the tokamak magnetic field as well as the driving strength. The electrons are modeled with a simple formula for the deviation from a near Boltzmann response and the ions are modeled as a nonlinear fluid. For sheared slab geometry suppressing curvature (or toroidal) effects, the turbulence level and transport scale according to the mixing length given by the linear normal mode widths and the poloidal wavelengths scaled to the ion gyroradius. Toroidal coupling results in a more complex behavior. 16 refs., 9 figs., 1 tab.

29631 (GA-A–20031) **Parasitic coupling of the fringing fields of an Ion-Bernstein wave antenna.** Chiu, S.C. (General Atomics, San Diego, CA (USA)); Chan, V.S.; Perkins, F.W.; Puri, S. General Atomics, San Diego, CA (USA). Apr 1990. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-89ER53277. (CONF-900602–6: 17. European conference on controlled fusion and plasma heating, Amsterdam (Netherlands), 25-29 Jun 1990). Order Number DE90009918. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Ion-Bernstein wave (IBW) heating is an important method of heating a tokamak plasma. In past experiments, the loading of an IBW antenna is known to be considerable higher than that predicted by linear theory. It was attributed to background loading due to unknown mechanisms. Here, we propose that a possible mechanism is the coupling of the fringing fields of the Faraday screen to a short wavelength electrostatic mode. This mode is highly dissipative and can be propagative or evanescent, depending on the edge parameters. The problem is formulated as a mixed boundary value problem and solved by singular integral technique. Numerical results indicate that this can be significant parasitic coupling mechanism whose magnitude at typical edge parameters can be significantly larger than the coupling to the desired IBW. It is insensitive to variation in magnetic field, which is in sharp contrast to theoretical predictions for IBW coupling. The dependence of the coupling to plasma and antenna parameters will be presented. Relevance to experiments will be discussed. 11 refs., 4 figs.

29632 (IPPCZ–284) **Control of plasma position in the CASTOR tokamak.** Valovic, M. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. Nov 1988. 16p. Order Number DE90623583. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

A simple servo-system designed for plasma position control in the CASTOR tokamak is described. Both radial and vertical plasma displacements were minimized using two servo-loops consisting of detection coils, a conventional electric controller and an amplifier operated as an unipolar voltage-controlled current source. To ensure the optimum conditions in the start-up phase of the discharge, currents in the servo-systems were externally preprogrammed. The prescribed plasma position was maintained with the accuracy of 3 mm. The feedback control improves plasma parameters, e.g. it removes the positional disruption at the end of the tokamak discharge. (J.U.). 4 figs., 3 refs.

29633 (IPPCZ–285) **Electron cyclotron emission and absorption experiment on the CASTOR tokamak.** Fedorenko, S.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii); Stoeckel, J.; Valovic, M.; Zacek, F. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. Nov 1988. 15p. Order Number DE90623584. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Electron cyclotron radiation and absorption measurements on the CASTOR tokamak are reported. Emission spectra were obtained using fast-scanning Fourier spectrometer and InSb detectors, operating in the spectral range 30 to 300 GHz and receiving two orthogonal polarization components simultaneously. In the high plasma loop voltage runaway electrons gave rise to an intense broad-band emission. Runaway particles can be removed by increasing the plasma density. The electron temperature profile was deduced from thermal emission and absorption around second cyclotron harmonics. From the second and third harmonics of the non-thermal emission the energy and number of non-thermal particles can be calculated. During the lower-hybrid-current-drive (LHCD) experiments, the presence of 60 keV electrons with density of 1.10^{16} m^{-3} was deduced from emission spectra. (author). 5 figs., 6 refs.

29634 (IPPCZ–286) **Gas-puff Z-pinch experiment.** Krejci, A. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. Nov 1988. 22p. Order Number DE90623585. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The fast linear Z-pinch was experimentally investigatedusing a pulse high-current generator (10.8 μF, 5 to 10 kJ. 150 to 250 kA) and a pulse injectionof argon and neon. Measured electrical characteristics of the discharge (current shape and risetime, inductance) and calculated dynamic parameters of plasma implosion (accelerated mass, radial plasma velocity) are presented. X-ray diagnostics with temporal resolution (vacuum X-ray diodes, semiconductor detectors) were utilized. The temperature and the density of pinch plasma ($T_e \simeq 50$ eV, $n_e \simeq 1.4x10^{26}$ m^{-3}) and its size and lifetime were estimated. Total energy emitted by pinch in ultra-soft X-ray region ($h\nu<1$ keV) during $\approx$ 200 ns pulse achieves 125 $J/4\pi$. (author). 5 figs., 1 tab., 16 refs.

29635 (IPPCZ–287) **Calculations of soft X-ray emission of REB-heated plasma.** Raus, J.; Babicky, V. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. Jan 1989. 41p. Order Number DE90623586. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The non-stationary corona model was used for the calculation of time-dependent soft X radiation spectra of REB-heated hydrogen plasma with 1% of oxygen. Electron impact ionization and excitation, spontaneous radiative decay and radiative and dielectronic recombination were taken into account. The plasma temperature was assumed to increase instantaneously to several tens of eV at the time t=0, remaining constant afterwards. The set of differential equations for ionization states of oxygen was solved using the Euler method. The plasma radiation spectra were computed in the range of 5 eV to 5 keV. The intensity of the continuum radiation component was is found to be not higher than 1% of that of the impurity lines. The theoretical signals of several X-ray detectors with various filters, calculated on the base of the time-dependent spectra obtained, may be directly compared with experimental data. (J.U.). 25 figs., 2 tabs., 26 refs.

29636 (IPPCZ–289) **Hot spots in Ar and Ne gas puff Z-pinch.** Krejci, A. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu); Krousky, E.; Renner, O. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. Feb 1989. 9p. Order Number DE90623587. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The hot spots in Ar and Ne pinch plasma were investigated. Two pinhole cameras with entrance diameter 13 to 250 μm and flat crystal spectrographs with Si and KAP crystals were used for spatially and spectrally resolved soft X-ray diagnostics. The diameters of Ar (25 to 30 μm) and Ne (40 μm) hot spots were found. From X-ray spectrum of Ar spots the following plasma parameters were determined: T_e=1.0 to 1.1 keV and n_e=(1.8 to 4.0)x10^{27} m^{-3}. The

validity of the Bennett equilibrium for unstable hot spots is discussed. (author). 1 fig., 11 refs.

29637 (IPPCZ–290) **Computation of coupling elements between waveguides and modes for large launching structures.** Hurtak, O.; Preinhaelter, J. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. 18p. Order Number DE90623632. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Optimization of large launching structures - grills and multijunction grills which are intended for lower hybrid current drive in big tokamaks - calls for quick and sufficiently precise computation of the coupling elements between waveguides and modes. The original method of computation is described which is efficient for small structures only and is based on integration along the real axis. For computation of coupling elements between more distant waveguides another method of integration is developed which uses a shift of the integration path. For this purpose, the analytical continuation of the plasma surface impedance into the complex N_z-plane is calculated and a new numerical code developed. Some numerical results are given to compare both methods. A combination of both methods speeds up the computation needed for the grill design. (author). 2 figs., 2 tabs., 2 refs.

29638 (IPPCZ–291) **Solar flares and dynamics of Langmuir waves in current-carrying plasmas.** Jungwirth, K. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu); Karlicky, M. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. 40p. Order Number DE90623633. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The dynamics of intense Langmuir waves in current-carrying plasma is studied both analytically and numerically. Starting with the widely used Zakharov equations adapted to these systems, specific features of the problem are pointed out. The role of resonant particles is analyzed. Using a one-dimensional macroparticle numerical code, nonlinear regimes of modified-decay and modulational instabilities are modelled. An efficient cooperation of essentially ponderomotive and electron-ion drift effects is demonstrated. It appears that the heating of a current-carrying plasma can be activated by releasing the inductively stored energy, due to the enhanced conversion of energy associated with the electron drift motion. The underlying physics is discussed and its relationship to the solar flare theory is suggested. (author). 6 figs., 1 tab., 30 refs.

29639 (IPPCZ–292) **Quasilinear approach to the damping of LH waves in a reactor-grade plasma.** Pavlo, P.; Krlin, L.; Tluchor, Z. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. Jun 1989. 31p. Order Number DE90623588. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The results are presented of a computer simulation of the lower hybrid current drive (LHCD) for ITER parameters. The damping of lower hybrid waves on alpha particles, due to the interaction at high cyclotron resonances, is obtained by solving the two-dimensional Fokker-Planck equation with the corresponding quasilinear term (FPA code). This code is incorporated into a one-dimensional LHCD code so as to obtain radial profiles of the RF power transferred to electrons and alpha particles as well as that of the driven current. A noticeable absorption by alpha particles is observed only below 5 GHz of the generator frequency and is bearable down to 3 GHz (22% of the input power with only 10% reduction in the total driven current for an optimized input spectrum.) The absorption is accompanied by acceleration of a group of alpha particles much above their born velocity. RF-induced alpha aprticle losses are found to be too small to affect the energy balance but may contribute to the deterioration of the first wall. Some further mechanisms not included into the code but possibly affecting the interaction are discussed. (author). 9 figs., 1 tab., 14 refs.

29640 (IPPCZ–293/I, pp. 1-23) **Generalization of characteristics of electric arc discharges.** Yas'ko, O.I. (AN Belorusskoj SSR, Minsk (Byelorussian SSR). Inst. Teplo- i Massoobmena). Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (In Russian). (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Use of the similarity theory in formulating generalized laws for complex physical systems such as various arc discharges exploited in laboratory and industrial plasmatrons, meets with serious difficulties. After having identified the predominant physical processes, we can nevertheless find for each such process one dimensionless parameter which can be used in generalized formulae. The plasma characteristics can then be expressed by a small number of dimensionless parameters; as a rule the parameters are different for different working gases. Recently a new approach to mathematical modeling of arcs was proposed, based on an analysis of the temperature dependence of plasma characteristics. The application of this method to the construction of generalized volt-ampere characteristics of arcs is shown by several examples. (J.U.).

29641 (IPPCZ–293/I, pp. 57-68) **Spectral characteristics of chemically active high-pressure plasma used for silicon nitride synthesis.** Simek, M. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu); Taras, P. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Emission spectra of hydrogen-nitrogen-silicon tetrachloride plasma mixtures were obtained as part of an investigation of high-pressure plasma reactivity aimed at the synthesis of nitrides. The plasma stream with the mass temperature of 5800 K was produced by an arc plasmatron with two gas inputs. $SiCl_4$ vapors in nitrogen carrier gas were injected radially downstream the anode nozzle. The emission spectra were analyzed by means of a Jobin-Yvon HR-320 on-line spectrograph. The influence of the hydrogen admixture on spectra of diatomic molecules such as SiN and SiH was studied. The number of SiN radicals found in the experiment was relatively low. It may be concluded that under the conditions of the experiment, nitrogen-containing compounds can be prepared only using hydrogen-nitrogen mixtures. (J.U.).

29642 (IPPCZ–293/I, pp. 69-83) **Plasma temperature measurements based on discrete atomic and molecular spectra - a critical discussion.** Zyrnicki, W. (Politechnika Wroclawska, Wroclaw (Poland). Inst. Chemii Nieorganicznej i Metalurgii Pierwiastkow Rzadkich). Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The analysis of emission spectra is an indispensable tool when studying the processes in chemically reacting plasmas, the plasma temperature being the most important and most frequently studied plasma parameter. The concept of plasma temperature is discussed in detail and the methods used for measurements of translational, vibrational, rotational and excitation temperatures are surveyed. The sources of inaccuracy of each method are critically analyzed and the role of microcomputers in spectroscopic data processing is emphasized. (J.U.).

29643 (IPPCZ–293/I, pp. 84-98) **Spectroscopic diagnostics of some plasmas used in technology processes.** Zyrnicki, W. (Politechnika Wroclawska, Wroclaw (Poland). Inst. Chemii Nieorganicznej i Metalurgii Pierwiastkow Rzadkich); Kulakowska, B.; Borkowska-Burnecka, J.; Taras, P.; Dudas, J. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The results are presented of joint spectroscopic studies of technological plasmas performed within the framework of sci-tech

cooperation of IPP, Prague and IICMRE, Wroclaw. The plasma spectra were recorded in Prague and analyzed in Wroclaw. In the first experiment a water plasma was generated by the Czechoslovak water-stabilized plasmatron PAL 160. Both a pure water plasma and that with additions of $ZrSiO_4$, Al_2O_3 and Al powders were investigated. In the second experiment a plasma jet producing a mixed hydrogen-nitrogen-$SiCl_4$ plasma was used. In the first experiment the spectra were recorded on ORWO plates by means of prism spectrograph Q 24. In the second experiment, Kodak plates and planar grating spectrograph PGS-2 were used. (J.U.).

29644 (IPPCZ–293/I, pp. 99-111) **On the potential of CARS spectroscopy in low-temperature plasma diagnostics.** Ambrazyavichyus, A.B. (AN Litovskoj SSR, Kaunas (USSR). Inst. Fiziko-Tekhnicheskikh Problem Ehnergetiki); Gladkov, S.M.; Grigajtis, Yu.P.; Koroteev, N.I. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (In Russian). (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The principles of coherent anti-Stokes Raman spectroscopy (CARS) and its application to the diagnostics of technological plasmas are briefly discussed. THe CARS spectrometer is described, developed in IPTPE, Caunas for investigations of a nitrogen plasma stream generated by an industrial plasmatron, and several CARS spectra of nitrogen molecules are presented. As the CARS signal from vibrational-rotational energy levels decreases substantially at plasma temperatures above 2000 K, an alternative scheme using electronlevels of atoms or ions has to be used. To test the method, CARS signals from the lines of the first nitrogen ion were studied in a low-voltage spark discharge. (J.U.).

29645 (IPPCZ–293/I, pp. 112-115) **The spectroscopic study of $SiCl_4$ in 400 kHz low pressure plasma etch reactor.** Jurani, R. (Komenskeho Univ., Bratislava (Czechoslovakia)); Trnovec, J. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The low-pressure high-frequency $SiCl_4$ discharge was studied spectroscopically in the range of 250-610 nm by means of the SPM-2 monochromator (Zeiss Jena). The typical discharge spectrum is presented and the observed and missing emission lines are identified. Discussed are some features of kinetics of the gas-phase processes which may be deduced from the experimental data. The physical mechanism responsible for two broad emission bands observed around 400 nm and 575 nm, however, remains unknown. (J.U.).

29646 (IPPCZ–293/I, pp. 129-134) **Substrate temperature distribution in microwave plasma used for polymer deposition.** Ohl, A. (Akademie der Wissenschaften der DDR, Greifswald (German Democratic Republic). Zentralinstitut fuer Elektronenphysik); Schmidt, M. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Thin film deposition in a microwave-generated plasma is studied. The finite depth of microwave penetration into the plasma results in a spatial inhomogeneity of plasma parameters and complicates the solution of energy balance equations at the substrate. In the investigation of plasma polymerization of hexamethyl disiloxane the substrate temperature is a critical parameter. Therefore, a special experimental setup was developed which makes it possible to measure the spatial distribution of temperature along the substrate. The experimental results are in good agreement with calculations based on a simple energy balance model. (J.U.).

29647 (IPPCZ–293/I, pp. 143-145) **Quick gas rotational temperature determination in a plasma reactor.** Janca, J. (Universita J.E. Purkyne, Brno (Czechoslovakia). Prirodovedecka Fakulta); Brablec, A.; Skricka, L.; Tesar, C. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Up to 1000 K the gas rotational temperature may be quickly determined from the measured spectral intensity of the second positive system (vibrational band 2-0) of a nitrogen molecule, making use of the pronounced temperature sensitivity of the shallow saddle minimum in the vibrational band. The results obtained theoretically were verified experimentally in a high-frequency excited nitrogen plasma. (J.U.).

29648 (IPPCZ–293/I, pp. 146-152) **Time stability influence of the FPI on the accuracy of measurement of spectral line profiles in plasma physics.** Stastny, F. (Universita J.E. Purkyne, Brno (Czechoslovakia). Prirodovedecka Fakulta); Brablec, A. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

The stability in time of Fabry-Perot interferometers with piezoelectric scanning of the line profiles is a problem in plasma diagnostics when spectral line profiles are to be measured with great accuracy. Stability tests were performed with a computer-controlled RC 150 (Burleigh, USA) interferometer. The experimental data revealed a systematic change of the interferometer constant on a long time scale, which cannot be neglected in accurate measurements. (J.U.).

29649 (IPPCZ–293/I, pp. 156-158) **Optical diagnostics of discharges.** Kapicka, V. (Universita J.E. Purkyne, Brno (Czechoslovakia). Prirodovedecka Fakulta); Kovar, L.; Tesar, C. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Some results of rotational temperature measurements in a capacity-coupled high-frequency discharge and of interferometric measurements of radial temperature distribution in an electric arc are reported. (J.U.).

29650 (IPPCZ–293/I, pp. 159) **Interference and schlieren diagnostics of current sheath generated by coaxial gun.** Kravarik, J. (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Elektrotechnicka); Kubes, P. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Published in summary form only. PLASMA DIAGNOSTICS/electric discharges; PLASMA GUNS/electron density; AIR; INTERFEROMETRY; SCHLIEREN METHOD

29651 (IPPCZ–293/I, pp. 153-155) **Double probe characteristics in the case of nonmaxwellian distributions of electrons.** Ferdinand, J. (Vysoka Skola Strojni a Elektrotechnicka, Plzen (Czechoslovakia)). Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

Contrary to the single Langmuir probe method, the electron temperature determined from the double probe characteristics by using the classical Malter-Johnson formula is independent of the electron energy distribution. The double probe method can therefore be used even when the detailed course of the electron distribution function is not known. (J.U.).

29652 (IPPCZ–293/I, pp. 116-118) **A study of equilibrium in argon arcs.** Vicek, J. (Vysoka Skola Strojni a Elektrotechnicka, Plzen (Czechoslovakia)). Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1989. (CONF-8903207–: 15. Czechoslovak seminar on plasma physics and technology, Liblice (Czechoslovakia), 13-17 Mar 1989). In *15th Czechoslovak seminar on plasma physics and technology. Part 1.* Order Number DE90623578. Available from NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS.

An extensive collisional-radiative model of an argon plasma is applied to atmospheric and subatmospheric arcs in argon. The deviations from local thermal equilibrium in these discharges are studied. The calculated values of the Boltzmann decrement are compared with those obtained in various experiments. (J.U.).

29653 (IPP–III/139) **ASDEX contributions to the 8th international conference on plasma surface interaction in controlled fusion devices, Juelich, May 2-6, 1988 and international workshop on plasma edge theory, Augustusburg (GDR), April 26-30, 1988.** Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1988. 149p. Order Number DE90780658. Available from NTIS (US Sales Only), PC A07/MF A01.

This report contains 10 lectures on various aspects of plasma - surface interactions and on plasma edge theory. (WL).

29654 (IPP–III/139, pp. 1-13) **Impurity accumulation studies in pellet-refuelled ASDEX discharges.** Fussmann, G.; Krieger, K.; Nolte, R.; Roehr, H.; Steuer, K.H. ASDEX Team. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1988. In *ASDEX contributions to the 8th international conference on plasma surface interaction in controlled fusion devices, Juelich, May 2-6, 1988 and international workshop on plasma edge theory, Augustusburg (GDR), April 26-30, 1988.* Order Number DE90780658. Available from NTIS (US Sales Only), PC A07/MF A01.

Pellet injection into ASDEX discharges allows considerable improvement of the confinement properties. Simultaneously with this improvement a strong accumulation of metallic impurities is observed, which leads to intolerable cooling of the plasma core region. We discuss the experimental phenomena and the underlying transport changes associated with the accumulation. (orig.).

29655 (IPP–III/139, pp. 14-33) **Characterization of the ASDEX scrape-off-layer density profile during neutral beam heating.** McCormick, G.K.; Pietrzyk, Z.A. ASDEX Team; NI-Team. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1988. In *ASDEX contributions to the 8th international conference on plasma surface interaction in controlled fusion devices, Juelich, May 2-6, 1988 and international workshop on plasma edge theory, Augustusburg (GDR), April 26-30, 1988.* Order Number DE90780658. Available from NTIS (US Sales Only), PC A07/MF A01.

The scrape-off-layer (SOL) density profile is characterized by the density at the separatrix n_s, and the e-folding length λ_n for ohmic and H^0-neutral-injection-heated (NI) plasmas at power levels P_{NI} leading either only to the L-mode (low power injection: P_{NI} = 0.4 - 1.7 MW), or to the H-mode (high power injection: P_{NI} = 2.4 - 3.4 MW). Behavior of the SOL at low P_{NI} is studied over the ranges: anti n_e = 1-5 x $10^{13}/cm^3$, I_p = 270 - 420 kA and B_t = 21.8 kG, for D^+ and He^{++} (only 420 kA) discharges. It is found: $n_s(OH) \propto$ anti $n_e\ I_p^{0.25}$; $n_s(L) \propto$ anti $n_e\ I_p^{-0.5}$ and $\lambda_n(OH+L) \propto$ anti $n_e^{-0.22}\ I_p^{-0.6}\ P_{tot}^{0.19}$, where P_{tot} is the total power absorbed by the plasma. More explicitly, n_s is proportional to anti n_e, whereby the constant of proportionality increases at the onset of NI, but is independent of P_{NI}. (orig.).

29656 (IPP–III/139, pp. 53-67) **The low energy neutral fluxes and their impurity production at the walls of ASDEX.** Verbeek, H.; Dose, V.; Fu, J.K.; Gehre, O.; Gernhardt, J.; Janeschitz, G.; Mueller, E.R.; Roehr, H.; Steuer, K.H.; Soeldner, F.X. ASDEX Team. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1988. In *ASDEX contributions to the 8th international conference on plasma surface interaction in controlled fusion devices, Juelich, May 2-6, 1988 and international workshop on plasma edge theory, Augustusburg (GDR), April 26-30, 1988.* Order Number DE90780658. Available from NTIS (US Sales Only), PC A07/MF A01.

With the Low Energy Neutral particle Analyser LENA at ASDEX the density dependence of the neutral flux, its mean energy and its impurity production at the walls has been investigated for ohmic hydrogen and deuterium discharges. For hydrogen a large increase of the neutral flux with increasing density was observed, while the mean energy of the neutrals decreases. This holds for hydrogen over the whole range of densities. At constant density the low energy neutral flux increases with the safety factor q. This is in contrast to the high energy flux as measured with the charge exchange analyser. The flux increase of the low energy neutrals can be correlated with the increased decay length of the electron density for higher q-values. For deuterium the same behaviour up to densities of $n \simeq 3.5 \times 10^{13}$ cm^{-3} was observed. For higher densities the flux behaves different corresponding to the different confinement regimes. Only in the regime of saturated ohmic confinement, known so far, the flux increases further with increasing n. With the operational conditions of the new divertor configuration in ASDEX a further increase of τ_E with n up to the density limit was observed (improved Ohmic confinement). In this regime the neutral flux saturates with increasing n. In spite of the reduced impurity production at the walls, Z_{eff} increases in this case. (orig.).

29657 (IPP–III/139, pp. 68-82) **Charge exchange neutral sputtering in ASDEX.** Staudenmaier, G. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Wampler, W.R. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1988. Contract DE-AC04-76DP00789. In *ASDEX contributions to the 8th international conference on plasma surface interaction in controlled fusion devices, Juelich, May 2-6, 1988 and international workshop on plasma edge theory, Augustusburg (GDR), April 26-30, 1988.* Order Number DE90780658. Available from NTIS (US Sales Only), PC A07/MF A01.

Neutral fluxes to the wall of ASDEX were measured with a new energy-resolving carbon resistance probe, CRP, combined with a mechanical shutter, providing time resolution. With the new CRP having two silicon overlayers of different thickness the non-Maxwellian energy distribution of the charge exchange neutrals can be approximately determined. Using the flux and the mean energy of the particles from the resistance probe measurements, one can calculate the flux of impurities generated by sputtering. Various discharges were investigated. High impurity fluxes were observed in discharges with high power auxiliary heating. Low impurity fluxes were observed in pellet-refuelled discharges and during neutral beam heating in counter direction and H-mode discharges refuelled with pellets. Charge exchange neutral sputtering is an important impurity source representing a lower limit for impurity generation. (orig.).

29658 (IPP–III/139, pp. 83-95) **Erosion and retention of the target plate material in the ASDEX divertor.** Janeschitz, G. (Association Euratom-Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)); Fussmann, G.; Hofmann, J.; Roth, J.; Taglauer, E.; Ran, L.B.; Yang, H.R. ASDEX Team; NI Team; ICRH Team. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1988. In *ASDEX contributions to the 8th international conference on plasma surface interaction in controlled fusion devices, Juelich, May 2-6, 1988 and international workshop on plasma edge theory, Augustusburg (GDR), April 26-30, 1988.* Order Number DE90780658. Available from NTIS (US Sales Only), PC A07/MF A01.

In this paper we describe experiments undertaken to evaluate the retention of target produced impurities in the ASDEX divertor. The titanium divertor plates have recently been replaced by water-cooled copper plates. Since copper is a material not previously present inside the ASDEX torus, a unique possibility existed to study the transport of the target plate material from the divertor chamber into the main plasma. By spectroscopic measurement of the Cu flux emerging from the target plate and of the Cu density in

the main plasma, the retention is assessed. We find a poor retention (R=1) for low n_e (n_e<3.0*10^{13} cm^{-3}) but a substantially improved one (R>30) at high densities. During additional heating (NI, ICRH) at the same density as in the OH case, the retention is lower, but approaches similar values at slightly higher densities. The retention seems to be independent of the heating power. (orig.).

29659 (IPP–III/139, pp. 96-107) **Measurements of the flux of metallic impurities to the ASDEX divertor plates.** Taglauer, E.; Martinelli, A.P.; Janeschitz, G. ASDEX Team. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1988. In *ASDEX contributions to the 8th international conference on plasma surface interaction in controlled fusion devices, Juelich, May 2-6, 1988 and international workshop on plasma edge theory, Augustusburg (GDR), April 26-30, 1988.* Order Number DE90780658. Available from NTIS (US Sales Only), PC A07/MF A01.

Metal impurity (Fe, Cu) fluxes to the divertor plates of ASDEX were measured using a collector probe during discharges with various plasma parameters. The Cu deposition shows generally a different distribution across the scrape-off layer compared to the Fe deposition. The maximum Cu deposition is close to the Cu divertor plates indicating evaporation or sputtering from these plates. In the center of the SOL, Fe-fluxes are indicative of the Fe content in the central plasma. Variations of the Cu and Fe fluxes with auxiliary heating and vessel carbonisation are analysed and discussed in view of impurity production mechanisms. (orig.).

29660 (IPP–III/139, pp. 108-128) **Material transport at the vessel walls of the divertor tokamak ASDEX.** Wang Wenmin; Roth, J.; Behrisch, R.; Staudenmaier, G. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1988. In *ASDEX contributions to the 8th international conference on plasma surface interaction in controlled fusion devices, Juelich, May 2-6, 1988 and international workshop on plasma edge theory, Augustusburg (GDR), April 26-30, 1988.* Order Number DE90780658. Available from NTIS (US Sales Only), PC A07/MF A01.

Carbon tiles and probes, which had been mounted on the vessel walls of the divertor tokamak ASDEX during different experimental periods as well as the Ti divertor plates removed in 1986 have been analysed with respect to deposition of D and metal atoms. The lowest Fe, Ni, Cr deposition (5 10^{15} cm^{-2}) was found at the area where the separatrix intersects the divertor plates, while the deposition is much larger (of the order of 10^{17} cm^{-2}) at the divertor entrance and the walls of the divertor chamber, as well as at the walls of the main discharge chamber. This indicates that metal atoms deposited at the divertor plates are re-eroded, while the final sink for plasma impurities are the walls of the divertor chamber and of the main plasma vessel. During the last operation period the plates were made from Cu and the Cu deposition on the vessel walls was found to increase with the number of discharges indicating material transport from the divertor chamber into the main plasma vessel. From the survey of metal atom deposition a material transport balance is established comparing impurity sources and sinks. (orig.).

29661 (IPP–III/139, pp. 129-144) **Plasma induced changes of a metallic divertor neutralizer plate from ASDEX analysed by photoacoustics.** Bein, B.K. (Bochum Univ. (Germany, F.R.). Inst. fuer Experimentalphysik 6 (Germany, F.R.)); Wojczak, M.; Pelzl, J. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1988. In *ASDEX contributions to the 8th international conference on plasma surface interaction in controlled fusion devices, Juelich, May 2-6, 1988 and international workshop on plasma edge theory, Augustusburg (GDR), April 26-30, 1988.* Order Number DE90780658. Available from NTIS (US Sales Only), PC A07/MF A01.

A metallic divertor neutralizer plate of the ASDEX tokamak has been analysed by photoacoustics, a thermal wave method with acoustic detection, to obtain space resolved thermal depth profiles and to characterize the plasma-induced changes of the plate material. In the intersection region between the plasma separatrix and the neutralizer plate where the maximum power deposition occurred during incorporation in ASDEX, the effusivity $\sqrt{}$koc, the thermophysical parameter relevant for time dependent surface heating processes, increased about 18% over its original value. (orig.).

29662 (J–550-90-601/2454) **Thermal barrier research: Final technical report, September 1985–June 1986.** Moses, K.G. JAYCOR, Torrance, CA (USA). Plasma Technology Div. 7 Mar 1990. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG03-85ER51095. Order Number DE90009213. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The thermal barrier region in the TARA device is a complex arrangement combining ion-plugging by sloshing ions with an ECRH-generated thermal barrier plasma. An axisymmetric, high-mirror-ratio magnetic field, adjacent to the central cell, provides the confinement of the thermal barrier plasma and sloshing ions. This paper discusses research being done in this thermal barrier region.

29663 (JAERI-M–89-209) **Study of marfe phenomena on JT-60.** Nishitani, Takeo (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Ishida, Shin-ichi. Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 33p. Order Number DE90777743. Available from NTIS (US Sales Only), PC A03/MF A01.

The marfe (Multifaceted Asymmetric Radiation From the Edge) is a poloidally asymmetric radiation band localized near the inside midplane and is a common phenomenon among middle and large size tokamaks like Alcator-C, ASDEX, TFTR and JET. In JT-60 marfe has been observed frequently in high-Ip and high density limited discharges with neutral beam heating. It can be explained as a radiative thermal instability caused by light impurities in a peripheral plasma. Though the marfe onset close to the density limit reduces the line averaged electron density, it does not affect the central electron temperature and the energy confinement. The marfe onset at relatively low Ip improves energy confinement time up to several % accompanied with the increase of electron density. (author).

29664 (JAERI-M–89-217) **A model of L-H transition.** Aikawa, Hiroshi (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 34p. Order Number DE90777756. Available from NTIS (US Sales Only), PC A03/MF A01.

A model of L-H transition in a tokamak plasma is presented. In the theory of the dissipative drift wave turbulence, the condition of $k^2\rho i^2 \simeq 1$ (k : wave vector normal to the magnetic field, ρi: ion Larmer radius evaluated by electron temperature) makes the theoretical procedures change from the fluid type to the kinetic one as $k\rho i$ grows over unity. This fact leads the diffusion coefficient induced by this instability to utterly different dependence of plasma parameters (especially electron temperature (T_e) dependence changes from $T_e^{5/6}$ to T_e^{-2} as $k^2\rho i^2$ changes from the value less than unity to the value more than unity). It is shown in the present paper that L-H transition can be induced by this change of plasma parameter dependence of the diffusion coefficient, and the threshold value of electron temperature is also presented. This model, using the radial profiles of electron density and temperature near the plasma circumference obtained by the experiment of ASDEX, shows a good explanation of L-H transition. The various characteristics of H-mode, having been obtained by the various tokamak machines with the various conditions, are discussed and also explained consistently. (author).

29665 (KAERI/RR–764/88) **Survey of fusion reactor technology start-up experiment of the KAERIT.** Kang, Hee Dong (Korea Advanced Energy Research Inst., Daeduk (Republic of Korea)); Hwang, Churl Kew; Lee, Kwang Won; In, Sang Ryul; Hwang, Soon Mo; Jung, Seung Ho; Oh, Byung Hoon; Yoon, Byung Joo; Yoon, Jae Sung. Korea Advanced Energy Research Inst., Daeduk (Republic of Korea). Dec 1988. 294p. (In Korean). Order Number DE90623624. Available from NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS.

This report describes the results of a study on the hydrogen gas breakdown for plasma initiation in the KAERIT tokamak, which is an iron core device with a major radius of 27 cm and a minor radius of 5 cm. This tokamak is designed to operate in a toroidal field of 4 T, a maximum plasma current of 100 kA, plasma temperature of 1 keV, and plasma density of 5 x 10^{13} cm^{-3}. At present this device is working in a toroidal field of 0.44 T, a maximum plasma current of 10 kA with pulse duration of 1.8 msec, and a maximum plasma

temperature of 39 eV at a plasma density of 1 x 10^{13} cm^{-3}. The results of the gas breakdown experiments well exhibit the unique characteristics of toroidal discharge. The minimum breakdown voltage is as low as 3 V. It is concluded that the error component of the toroidal magnetic field and the stray fields from the scattered current sources have decisive influence on the discharge initiation. Displacement of the plasma column out of the equilibrium position, due to inadequate control of the equilibrium field, is the most positive cause of the major disruption of the plasma. Theoretical estimation of the temporal evolution of the plasma parameters and interrelation between them by the zero-dimensional calculation model interprets suitably the experimental results at least in the early phase of the current rise stage. This theoretical model can be used to predict the performance of the KAERIT tokamak following upgrade to the design specifications. (Author).

29666 (LRP–305/86) **Efficiency optimization for quasi-optical gyrotrons.** Isaak, B. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Bondeson, A.; Tran, M.Q.; Perrenoud, A.; Alberti, S.; Muggli, P. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Aug 1989. 50p. Order Number DE90623594. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Optimization studies for resonator cavities of quasi-optical gyrotrons have been carried out. With the constraint that the RF field is limited by peak power load on the mirrors, the electronic efficiency can have a value of up to 10% higher than the confocal results by using spherical mirrors with g=1-d/R close to -1. Optimized nonspherical cavities yield similar results. When output coupling through circular slots is considered, confocal (g=0) as well as more extreme designs near the resonator stability boundary are less favorable and the optimum configurations found are spherical mirrors with g-factors of about -0.3, -0.6, and possibly -0.75. (author) 16 figs., 1 tab., 8 refs.

29667 (LRP–348/88) **Ballooning instabilities in tokamaks with sheared toroidal flows.** Cooper, W.A. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). May 1988. 17p. Order Number DE90620691. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The ballooning-mode eikonal representation is applied to the linearised incompressible magnetohydrodynamic (MHD) equations in axisymmetric systems with toroidal mass flows to obtain a set of initial value partial differential equations in which the time t and the poloidal angle θ are the independent variables. To derive these equations, the eikonal function S is assumed to satisfy the usual conditions $b.\nabla S = 0$ to guarantee that the modes vary slowly along the magnetic field. In addition, to resolve the $V.\nabla$ operator acting on perturbed quantities, the eikonal must also satisfy the condition $dS/dt = 0$. This induces a Doppler shift in S. In a flux coordinate system (s,θ,ϕ) with straight magnetic field lines, we have that $S=\phi-q(s)\theta-\Omega(s)t+k(s)$, where q, Ω and k are functions only of the radial coordinate s and represent the safety factor, the plasma rotation frequency and the radial wave number, respectively. This description of the instability, however, is incompatible with normal mode solutions of the MHD equations because the wave vector ∇S becomes time dependent when the velocity shear is finite. Nevertheles, we are able to investigate the effects of sheared toroidal flows on localised ballooning instabilities because the initial value formulation does not constrain the solutions to evolve as $\exp(i\omega t)$. Fixed boundary MHD equilibria with isothermal toroidal flows that model the JET device value equations are evolved in time, periodic bursts of ballooning activity are observed which are correlated with the formation of a ballooning structure at the outside edge of the torus that becomes displaced by 2π in the extended poloidal angle domain from one burst to the next. The frequency of these bursts depends only on the velocity shear and the instability growth rates extracted from the peak values of the bursts are virtually linear. (Abstract Truncated)

29668 (LRP–349/88) **The laser, measuring instrument for plasmas.** Anderegg, F. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Behn, R.; Paris, P.J.; Salito, S.A.; Siegrist, M.R.; Weisen, H. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jun 1988. 62p. (In French). Order Number DE90623595. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

There are several different and in general complementary methods for the investigation of plasmas. All of them have different characteristics and properties covering a large spectrum of physical measuring techniques. Electromagnetic waves serving as 'thermometers' permit to detect the global behaviour of the plasma as well as that of the particles composing it. One of the advantages of these introspective methods is that it brings information on temporary and local conditions of the domain being interrogated. With the development of micro-wave sources and lasers after the war the principal tools of this type of plasma diagnostics are now available. In this paper the emphasis is on the lasers which are different according to the type of measurement. Their versatility in measuring plasma parameters is largely acknowledged. We illustrate the potential of measuring methods by lasers by means of the research work done at two experimental installations of CRPP. (author) 21 figs., 8 refs.

29669 (LRP–391/89) **Determination of central q and effective mass on TEXTOR based on Discrete Alfven Wave (DAW) spectrum measurements.** Descamps, P. (Ecole Royale Militaire, Brussels (Belgium). Lab. de Physique des Plasmas); Wasserhove, G. van; Koch, R.; Messiaen, A.M.; Vandenplas, P.E.; Lister, J.B.; Marmillod, Ph. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Dec 1989. 16p. Order Number DE90623596. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

The use of the Discrete Alfven Wave spectrum to determine the current density profile and the effective mass density of the plasma in the TEXTOR tokamak is studied; the measurement, the validity of which is discussed, confirms independently the central $q(r=0)<1$ already obtained by polarimetry. (author) 5 figs., 1 tab., 10 refs.

29670 (LRP–395/90) **The frequency splitting of the axisymmetric magnetoacoustic wave as a current profile diagnostic.** Borg, G.G. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)); Dudok de Wit, T. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Jan 1990. 20p. Order Number DE90623616. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

In the presence of finite plasma current, the axisymmetric (m=0) magnetoacoustic wave resonance exhibits a frequency splitting for finite toroidal mode number ($n \neq 0$) between oppositely directed travelling waves. Calculations are presented which demonstrate that $\Delta(1/f)$, the difference between the inverse resonance frequencies, is directly proportional to known moments of the plasma current profile and, in the limit where the radial wavenumber is much larger than the parallel wavenumber, is independent of the plasma mass density and its profile. Some aspects of the implementation of a current profile diagnostic based on the excitation of these resonances are also considered. (author) 16 refs., 6 figs., 1 tab.

29671 (PPLK-R–36) **Analysis on scrape off layer plasma in toroidal helical systems.** Itoh, K.; Nagasaki, K.; Itoh, S.-I.; Fukuyama, A. Kyoto Univ., Uji (Japan). Plasma Physics Lab. Jan 1989. 29p. Order Number DE90777723. Available from NTIS (US Sales Only), PC A03/MF A01.

Connection length of the magnetic field line to the wall in the scrape off layer (SOL) plasma is analysed in the toroidal helical systems. It is found that the connection length L has a logarythmic dependence on the distance from the outermost magnetic surface. Based on this result, we apply an analytic study on the plasma distribution in the SOL plasma. The edge temperature T_b approximately scales as $P^{0.36}$ as in the case of tokamaks, where P is the power flow to SOL region. For a given value of P, T_b is lower than that of tokamaks with similar minor radius. (author).

29672 (PPLK-R–37) **Design study of ion temperature measurement by collective Thomson scattering in Heliotron E.** Takeiri, Y. (and others); Sudo, S.; Tsukishima, T. Kyoto Univ., Uji (Japan). Plasma Physics Lab. Feb 1989. 45p. Order Number

DE90777725. Available from NTIS (US Sales Only), PC A03/MF A01.

Design study is carried out of ion temperature measurement system by collective far-infrared laser scattering, with the intention of applying it to the Heliotron E device. The measurement system consists of a D_2O laser, beam transmission optics for both incident and scattered light, and a dual homodyne detection system. Compared with the conventional systems where a heterodyne method is used for the signal detection, improvements of signal-to-noise ratio (S/N) and frequency resolution are expected in this system, because the dual homodyne method causes no deterioration of S/N by the stray light of the incident beam. We show that the S/N of the dual homodyne method is the same S/N as the so-called post detection and that the spectrum width of the laser light caused by the amplitude fluctuation gives the frequency resolution in the dual homodyne method. The scattered powers are evaluated for various operation modes of Heliotron E. It is shown that a 200 kW output power of the D_2O laser with a pulse duration longer than 1 μs is required to make the T_i measurement for neutral beam heated plasmas with n-bar$_e$ = (2.5-10) x 10^{13} cm^{-3} and T_i = (300-1200) eV. It is also shown that T_i can be determined with sufficient accuracy by means of the least square fitting of the measured spectrum to theoretical one, assuming a Maxwellian velocity distribution, provided the post detection S/N is larger than 3. For pumping the D_2O laser, two systems using TEA CO_2 laser, namely, a multi-stage amplifier system and an injection locking system are examined. They are compared in terms of compactness and frequency-stability. The accessibility to the Heliotron E device is also discussed. (author).

29673 (PPLK-R–38) **Parametric scaling studies of energy-confinement time for neutral-beam-heated Heliotron-E plasmas.** Sano, F. (and others); Takeiri, Y.; Hanatani, K. Kyoto Univ., Uji (Japan). Plasma Physics Lab. Feb 1989. 49p. Order Number DE90777732. Available from NTIS (US Sales Only), PC A03/MF A01.

Kinetic analysis of the global energy confinement time for neutral-beam-heated Heliotron-E plasmas has been performed with the 1-D, time-independent transport analysis code, PROCTR-Mod. Beam-power scans were performed by firing various number of hydrogen neutral beams, while density scans were performed by puffing gas and/or pellet fueling under the metallic or carbonized wall conditions. The wall carbonization facilitated the density increase due to the enhanced particle recycling on the walls, and also enabled long-pulse, quasi-stationary, currentless ECH + NBI operation with reduced heavy-impurity contamination. The data analysis shows that the favorable density dependence partially offsets the unfavorable power dependence, and that the anomalous electron transport loss becomes dominant in the over-all energy balance as the beam power and plasma density are increased. An alternative scaling law is also presented which is to fit $\tau_E{}^G$ [ms] by an 'offset-linear' law. The latter scaling is found to provide a better fit to the presented data sets in spite of its simple form. The parametric scaling of the local electron thermal diffusivity, χ_e, is also discussed on the basis of the kinetic analysis. (J.P.N.).

29674 (PPLK-R–40) **Scalings of energy confinement and density limit in stellarator/heliotron.** Sudo, S.; Takeiri, Y.; Zushi, H.; Sano, F.; Itoh, K.; Kondo, K.; Iiyoshi, A. Kyoto Univ., Uji (Japan). Plasma Physics Lab. Apr 1989. 31p. Order Number DE90777730. Available from NTIS (US Sales Only), PC A03/MF A01.

Empirical scaling of energy confinement observed experimentally in stellarator/heliotron (Heliotron E, Wendelstein 7A, L2, Heliotron DR) under the condition that plasmas are heated by ECH and/or Nbl is proposed. Empirical scaling of density limit obtainable under the optimum condition is proposed. These scalings are compared with those of tokamaks. The energy confinement scaling has similar power dependence as 'L mode scaling' of tokamaks. The density limit scaling seems also to indicate the upper limit of achievable density in many tokamaks. Combining the energy confinement time and the density limit scaling a transport-limited beta value is also deduced. Thus, from the viewpoint of designing a machine, there should be some compromise in determing magnetic field strength on plasma axis, average minor radius and major radius, because their dependence on confinement time and transport-limited beta value is contradicting. (J.P.N.).

29675 (PPLK-R–41) **Equilibrium, stability, and deeply trapped particle orbit calculations for l = 2 torsatron/heliotron configurations.** Nakamura, Y.; Wakatani, M.; Leboeuf, J.N.; Carreras, B.A.; Dominguez, N.; Holmes, J.A.; Lynch, V.E.; Painter, S.L.; Garcia, L. Kyoto Univ., Uji (Japan). Plasma Physics Lab. Jun 1989. 48p. Order Number DE90777729. Available from NTIS (US Sales Only), PC A03/MF A01.

Confinement properties of l = 2 torsatron/heliotron configurations with number of toroidal field periods, M, in the range 10 to 14 are studied. This involves the calculation of zero-current and flux conserving equilibria; stability against Mercier modes and low-n ideal modes, with n denoting the toroidal mode number; and orbit confinement of deeply trapped energetic particles. Optimization of both magnetohydrodynamic (MHD) and transport properties is pursued under the condition of plasma aspect ratio A = R/a $\geq$ 7, with R the major radius and a the average plasma radius. For configurations with M $\leq$ 12, an average MHD beta limit of 4 % to 5 % is possible. The addition of a quadrupole field improves the confinement of trapped particles at zero pressure, but particle losses increase with increasing beta. This loss is less severe if the vacuum magnetic axis is shifted slightly inward. A configuration with M = 10, a coil pitch parameter p_c in the range 1.25 to 1.30, and an added quadrupole field satisfies the beta and energetic particle confinement requirements for the next generation of large torsatron/heliotron devices. (author).

29676 (PPLK-R–44) **Third harmonic electron cyclotron heating of overdense plasmas in Heliotron DR.** Yanagi, N. (and others); Sato, M.; Morimoto, S. Kyoto Univ., Uji (Japan). Plasma Physics Lab. Jul 1989. 47p. Order Number DE90777726. Available from NTIS (US Sales Only), PC A03/MF A01.

Third harmonic electron cyclotron heating has been experimentally studied in Heliotron DR (R = 90cm, a-bar$_p$ $\simeq$ 7cm) by using a 28GHz, 200kW gyrotron. When the line averaged electron density, n-bar$_e$, exceeds a certain critical value of $n_{e,crit} \approx 0.5 \times 10^{13}/cm^3$, absorption power rapidly increases, and plasmas are substantially heated as long as the third harmonic resonant layers locate within the last closed magnetic surface. On the other hand, heating of the bulk plasma is not effective at the lower density of n-bar$_e$ < $n_{e,crit}$ although strong hard X-ray is radiated which suggests the generation of high energy electrons. In the high density regime, we observed that the central region of plasma is heated even when the electron density exceeds much higher than the cut-off value of O-mode (overdense plasma) almost independent of the location of resonant layers. We have found that the overdense plasma produced by the third harmonic heating have basically the same characteristics as those observed in the second harmonic heating. Electron Bernstein wave is considered to be concerned with the heating of overdense plasma in the third harmonic condition. (author).

29677 (PPPL–2674) **High-β operation and MHD [magnetohydrodynamic] activity on TFTR.** McGuire, K. Princeton Univ., NJ (USA). Plasma Physics Lab. Apr 1990. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. (CONF-891106–11: 31. annual meeting of the Division of Plasma Physics of the American Physical Society, Anaheim, CA (USA), 13-17 Nov 1989). Order Number DE90008199. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Magnetohydrodynamic (MHD) activity within three zones (core, half- radius, and edge) of TFTR [Plasma Physics and Controlled Nuclear Fusion Research (1986), (IAEA, Vienna, 1987), Vol. 1, P. 51] tokamak plasmas are discussed. Near the core of the plasma column, sawteeth are often observed. Two types of sawteeth are studied in detail: one with complete, and the other with incomplete magnetic reconnection. Their characteristics are determined by the shape of the q profile. Near the half-radius the m/n = 3/2 and 2/1 resistive ballooning modes are found to correlate with a beta collapse. The pressure and the pressure gradient at the mode rational surface are found to play an important role in stability. MHD activity is also studied at the plasma edge during limiter H-modes. The Edge Localized Mode (ELMs) are found to have a precursor mode

with a frequency between 50–200 kHz and a mode number m/n = 1/0. The mode does not show a ballooning structure. While these instabilities have been studied on many other machines, on TFTR the studies have been extended to high pressure (plasma pressure greater than 4×10^5 Pa) and low collisionality. 16 refs., 3 tabs.

29678 (PPPL–2686) **Loss of alpha-like MeV fusion products from TFTR.** Zweben, S.J.; Boivin, R.L.; Diesso, M.; Hayes, S.E.; Hendel, H.W.; Park, H.; Strachan, J.D. Princeton Univ., NJ (USA). Plasma Physics Lab. Mar 1990. 72p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE90008193. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

A detailed comparison between the observed and expected loss of alpha-like MeV fusion products in TFTR is presented. The D-D fusion products (mainly the 1 MeV triton) were measured with an 2-D imaging scintillation detector. The expected first-orbit loss was calculated with a simple Lorentz orbit code. In almost all cases the measured loss was consistent with the expected first-orbit loss model. Exceptions are noted for small major radius plasmas and during strong MHD activity. 37 refs., 28 figs.

29679 (Rijnhuizen-report–89-181) **FOM-Rijnhuizen contributions to 16th European conference on controlled fusion and plasma physics, Venice, March 13-17, 1989.** Euratom-FOM-NWO Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Mar 1989. 51p. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). Order Number DE90623580. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This report contains 9 conference contrubutions which are all in INIS scope, entitles respectively: A method for local transport analysis in tokamaks; Expansions of the flux and the current density in toroidal systems; Density fluctuation measurements in the TORTUR tokamak; A time-of-flight spectrometer for detection of low energetic hydrogen atoms; The observation of non-thermal features by tangential Thomson scattering at the TORTUR tokamak; ECRH as a research tool on RTP; Current drive by electron cyclotron waves in NET; Current density profile control by electron cyclotron current drive in NET; (H.W.). 56 refs.; 32 figs.; 18 schemes; 3 tabs.

29680 (Rijnhuizen-report–89-181, pp. 1-6) **A method for local transport analysis in tokamaks with error calculation.** Hogeweij, G.M.D. (Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica); Lopes Cardoze, N.J.; Hordosy, G. Euratom-FOM-NWO Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Mar 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *FOM-Rijnhuizen contributions to 16th European conference on controlled fusion and plasma physics, Venice, March 13-17, 1989.* Order Number DE90623580. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

A new method to solve the equation for the heat transport in a tokamak is presented which expresses the local heat resistivity $\rho(r)$ as a cosine series. The coefficients of this series are given as linear combinations of the Fourier coefficients of the measured temperature-and q-profiles, where q is the heat flux per unit area. This formulation allows the stable and accurate calculation of the ρ-profile, and the analytical calculation of the error in this profile. (author). 5 refs.; 3 figs.; 10 schemes.

29681 (Rijnhuizen-report–89-181, pp. 28-33) **ECRH as a research tool on RTP.** Polman, R.W. (Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica); Smits, F.M.A.; Manintveld, P.; Oomens, A.A.M.; Schueller, F.C.; Verhoeven, A.G.A. Euratom-FOM-NWO Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Mar 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *FOM-Rijnhuizen contributions to 16th European conference on controlled fusion and plasma physics, Venice, March 13-17, 1989.* Order Number DE90623580. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The new Rijnhuizen Tokamak Project (RTP) is dedicated to studies of transport mechanisms in fusion relevant tokamak plasmas. The former Grenoble tokamak PETULA has been adapted to these studies. A 60 GHZ, 600 kW Electron Cyclotron Resonance Heating system, that will be used for strong Auxiliary heating, es described in this report. (H.W.). 7 refs.; 5 figs.

29682 (Rijnhuizen-report–89-181, pp. 34-39) **Collective scattering from 60 GHZ ECRF waves at RTP.** Kim, S.K. (Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica); Hugenholtz, C.A.J.; Donne, A.J.H.; Peebles, W.A.; Luhmann, N.C. Jr. Euratom-FOM-NWO Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Mar 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *FOM-Rijnhuizen contributions to 16th European conference on controlled fusion and plasma physics, Venice, March 13-17, 1989.* Order Number DE90623580. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

In this paper the feasibility is discussed of collective Thomson-scattering measurements of various (fully or partially) electrostatic waves involved in Electron Cyclotron Resonance Heating (ECRH). utilizing radiation sources in the infrared or far-infrared region. The information thsu obtained will help understand the physics mechanism(s) of the heating process with ECRF waves. (author). 6 refs.; 3 figs.

29683 (Rijnhuizen-report–89-181, pp. 40-45) **Current drive by electron cyclotron waves in NET.** Giruzzi, G. (Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica); Schep, T.J.; Westerhof, E. Euratom-FOM-NWO Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Mar 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *FOM-Rijnhuizen contributions to 16th European conference on controlled fusion and plasma physics, Venice, March 13-17, 1989.* Order Number DE90623580. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

A potentially attractive scenario for steady-state operations in the Next European Torus relies on the use of lower-hybrid (LH) waves for non-inductive current drive in the plasma periphery and of electron cyclotron (EC) waves in the aim of determining the best options for the ECN current drive system and of evaluating the expected current drive efficiency. (author). 7 refs.; 6 figs.; 1 tab.

29684 (Rijnhuizen-report–89-181, pp. 12-16) **Density fluctuation measurements in the TORTUR tokamak.** Remkes, G.J.J. (Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica); Barth, C.J.; Groot, B. de; Kim, S.K.; Kluiver, H. de; Laan, H.A. van der; Donne, A.J.H. Euratom-FOM-NWO Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Mar 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *FOM-Rijnhuizen contributions to 16th European conference on controlled fusion and plasma physics, Venice, March 13-17, 1989.* Order Number DE90623580. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

A method is described for measurement of density fluctuations due to plasma turbulence in the TORTUR tokamak. (author). 3 refs.; 5 figs.

29685 (Rijnhuizen-report–89-181, pp. 17-21) **A time-of-flight spectrometer for detection of low energetic hydrogen atoms.** Toledo, W. van (Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica); Bree, A.R. de; Buuren, R. van; Kluiver, H. de; Donne, A.J.H. Euratom-FOM-NWO Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Mar 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *FOM-Rijnhuizen contributions to 16th European conference on controlled fusion and plasma physics, Venice, March 13-17, 1989.* Order Number DE90623580. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

This paper is concerned with a time-of-flight method that requires direct detection of low-energetic neutral hydrogen atoms that are released from wall and limiters of a tokamak, and is able to detect hydrogen or deuterium atoms with an energy down to 10 eV. (author). 6 refs.; 4 figs.

29686 (Rijnhuizen-report–89-181, pp. 22-27) **The observation of non-thermal features by tangential Thomson scattering at the TORTUR tokamak.** Lammeren, A.C.A.P. van (Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica); Barth, C.J.; Donne, A.J.H.; Est, Q.C. van; Verhaag, G.C.H.M. Euratom-FOM-NWO Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Mar 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *FOM-Rijnhuizen contributions to 16th European conference on controlled fusion and plasma physics, Venice, March 13-17, 1989.* Order Number DE90623580. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Tangential Thomson scattering at TORTUR plasmas was set-up to determine the local current density. The results demonstrate that the velocitiy distribution of mildly turbulent plasmas in non-Maxwellian, which is of great importance for transport computations. A complete tangential spectrum has been measured by a single laser pulse. (author). 10 refs.; 4 figs.

29687 (Rijnhuizen-report–89-181, pp. 7-11) **Expansions of the flux and the current density in toroidal systems.** Milligen, B.P. (Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica). Euratom-FOM-NWO Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Mar 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *FOM-Rijnhuizen contributions to 16th European conference on controlled fusion and plasma physics, Venice, March 13-17, 1989.* Order Number DE90623580. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The magnetic equilibrium in tokamaks is described by the Grad-Shafranov (GS) equation. The flux function is expanded in a set of solutions of the homogeneous GS equation. The expansion coefficients, called multipolar moments, are however not simply related to physically more meaningful global plasma parameters. Current moments, on the other hand, are widely used to obtain such global plasma parameters. In this paper a method is presented for obtaining relationships between multipolar and current moment. (author). 6 refs.; 1 fig.; 6 schemes; 1 tab.

29688 (Rijnhuizen-report–89-181, pp. 46-51) **Current drive density profile controle by electron cyclotron current drive in NET.** Giruzzi, G. (Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica); Shep, T.J.; Westerhof, E. Euratom-FOM-NWO Collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. Mar 1989. (CONF-890302–: 16. European conference on controlled fusion and plasma physics, Venice (Italy), 13-17 Mar 1989). In *FOM-Rijnhuizen contributions to 16th European conference on controlled fusion and plasma physics, Venice, March 13-17, 1989.* Order Number DE90623580. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The possibility of current density profile control in NET (Next European Torus) with ECCD (Electron Cyclotron Current Drive) is investigated. As an example profile control around the q=2 surface is studied. This is of particular interest, as the m=2, n=1 tearing mode, which is driven unstable by the current gradient inside the q=2 surface, is a major cause of disruptions. (author). 6 refs.; 2 figs.; 2 schemes; 1 tab.

29689 (Rijnhuizen-report–89-185) **Fundamentals of collective scattering experiments.** Remkes, G.J.J. Euratom-FOM-NWO collaboration. Associatie Euratom-FOM, Nieuwegein (Netherlands). FOM-Instituut voor Plasmafysica. May 1989. 53p. Available from Library KNAW; P.O.Box 41950, 1009 DD, Amsterdam, Netherlands.

Includes list of symbols.

Aspects of collective scattering of mm and sub-mm radiation on density fluctuations in laboratory plasmas have been described. The fluctuation level at a value of the density wave vector k has been expressed in terms of observable quantities, the k-resolution and the scattering volume which in turn have been expressed in terms of beam parameters. This yielded an expression for the fluctuations at k in terms of observable quantities and beam parameters valid for microwave scattering. The total fluctuation level has been found from a summation of the fluctuation levels at different k. This has been done for the cases of spherical isotropy and of isotropy is the poloidal plane. Expressions have been derived for the minimum source power needed in scattering experiments. It has been done for a one-channel detection system without transmission losses and for a multi-channel system with transmission losses. The derivations have been extended, to include the effect of the presence of plasma radiation. All derivations and calculations have been performed for heterodyne detection and for balanced mixing systems. It was found that the values of the minimum required source power are comparable for both methods of detection. Furthermore the minimum source power increases with decreasing wavelength and depending on the applied wavelength. Plasma radiation can considerably effect the minimum source power needed. For tokamaks with B = 3T the source wavelength must be smaller than 1 mm because of the electron cyclotron emission. Thereforemolecular lasers are recommended for a source. A homodyne one-channel balanced mixing system used on TORTUR has been treated. It was found that with the available 65 mW klystron a fluctuation level of 10^{-3} can be observed. This is a value considerably smaller than the fluctuations expected from the mixing length argument in turbulent transport theories. 17 refs.; 14 figs.; 144 schemes; 7 tabs.

29690 **A cw dye laser system for Li beam spectroscopy in a tokamak.** West, W.P. (GA Technologies, Inc., Oak Ridge, TN (USA)); Thomas, D.M. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) ([1990]). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The current density profile diagnostic employs a cw dye laser system to induce fluorescence in a Li beam injected into a tokamak. This laser has spectral and polarization modulation requirements not available in commercial systems. The required spectrum is a bandwidth of approximately 5 GHz at a wavelength of 667 nm. The bandwidth of the laser needs to be filled in as nearly as possible, i.e., a quasi-continuum within the 5 Ghz bandwidth. The polarization of the laser must remain linear, but the plane of polarization must be rotated at a high frequency, ~ 50 kHz. The details of the Li atomic spectroscopy in a tokamak and the requirements of the diagnostic system that lead to these requirements are addressed. The laser system and polarization modulator which have been developed are discussed in detail, including both design and performance parameters. Possible improvements to enhance performance are also discussed.

29691 **ECHR absorption and propagation studies via collective Thomas scattering.** Peebles, W.A. (California Univ., Berkeley, CA (USA)); Kim, Luhmann, N.C., Jr.; Zimmerman, P. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Electron cyclotron resonance heating ECRH has made rapid progress over the last few years due primarily to improved gyrotron source technology. The unique ability of ECRH to deposit energy locally offers numerous advantages such as the ability to preionize, initiate, control and heat fusion plasmas. However, wave propagation and absorption mechanisms are not well understood and the fusion community could benefit from a nonperturbing monitor of ECRF wave activity. The use of FIR collective Thomson scattering techniques on the upcoming ECRH experiment on TEXT is described. The intention is to probe both $k_{\parallel}$ and $k_{\perp}$ ECRF wave activity as well as simultaneously monitoring microturbulence levels. The existing source frequency of 245 GHz will experience a large frequency shift (~60 GHz) after scattering from ECRF waves. This has a number of important consequences for the accurate interpretation of scattering data. These are described in detail, as are alternative CO_2 and FIR laser scattering schemes.

29692 **Electron cyclotron measurements with the fast scanning heterdyne radiometer on the tokamak fusion test reactor.** Taylor, G, (Princeton Univ., NJ (USA)); Efthimion, P.C.; McCarthy,

M.P.; Fredd, E.A.; Cutler, R.C. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Three fast scanning heterodyne receivers, swept between 75-110 GHz, 110-170 GHz, and 170-210 GHz, have measured electron cyclotron emission on the horizontal midplane of the tokamak fusion test reactor (TFTR) plasma. A second harmonic microwave mixer in the 170-210 GHz receiver allows the use of a 75-110 GHz backward wave oscillator as a swept local oscillator. Electron temperature profile evolution data with a time resolution of 2 msec and a profile acquisition rate of 250 Hz are presented for gas-fuelled and pellet-fuelled ohmic and neutral beam heated plasmas with toroidal fields up to 5.2 tesla. Recent results from a swept mode absolute calibration technique which can improve the accuracy and data collection efficiency during in-situ calibration are also presented.

29693 Optically thin perpendicular electron-cyclotron emission from hot electrons in TMX-U. James, R.A. (Lawrence Livermore National Lab., CA (USA)); Lasnier, C.J.; Ellis, R.F. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report perpendicular electron-cyclotron emission (PECE) from relativistic (T_H~100 to 400 keV) hot electrons within the thermal-barrier region of TMX-U detected at 60 GHz and 94 GHz. For the operating regime of TMX-U these signals are optically thin and therefore proportional to the hot electron radial line density. These signals are used in determining the temporal evolution of the hot electron density, n_H, and temperature, T_H, in combination with a relativistic code to calculate the temperature dependence of the respective perpendicular emission coefficients. This dependence has been experimentally verified by x-ray measurements of T_H. Due to an inability to absolutely calibrate the present PECE optical system, T_H is cross-calibrate with x-ray measurements and n_H is normalized to diamagnetic loop measurements.

29694 Data structures for the description of tokamak diagnostics. Hertweck, F. (IPP Gorching (US)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The data acquisition system for the ASDEX-upgrade experiment is a distributed system, consisting of about 30 autonomous diagnostic subsystems (ADS), typically a micro VAX or similar running with UNIX, a central data analysis system (CDAS), on an IBM 4381 main frame with one CPU and at least 16 Mytes of memory, and a fiber glass connection network, permitting a transfer rate of at least 100 Kytes/sec from each ADS, and a total through-put of at least I Mytes/sec. The author reports on an open-ended file structure designed to describe shot-files. For each entity, like a CAMAC device, the diagnostic descriptor, a signal or a signal group, a time base, etc., an object descriptor exists in the file that permits the automatic collection of CAMAC data by an ACQUIRE task: a list of these objects, together with a mapping function, specifies how signals are constructed from the contents of CAMAC memories. The shot file thus constructed for each diagnostic on its ADS is sent to the CDAS where all data are spread out in memory. The shot file structure is complemented with a set of access procedures (usable by FORTRAN77 programs) that permit access to a shotfile (also older ones), to individual diagnostics of it, and their signals by using the appropriate symbolic names.

29695 Physics analysis database for the DIII-D tokamak. Schissel, D.P. (GA Technologies, Inc., Oak Ridge, TN (USA)); Bramson, G.; DeBoo, J.C. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report on a centralized database for handling reduced data for physics analysis implemented for the DIII-D tokamak. Each database record corresponds to a specific snapshot in time for a selected discharge. Features of the database environment include automatic updating, data integrity checks, and data traceability. Reduced data from each diagnostic comprises a dedicated data bank (a subset of the database) with quality assurance provided by a physicist. These data banks will be used to create profile banks which will be input to a transport code to create a transport bank. Access to the database is initially through FORTRAN programs. One user interface, PLOTN, is a command driven program to select and display data subsets. Another user interface, PROF, compares and displays profiles. The database is implemented on a Digital Equipment Corporation VAX 8600 running VMS.

29696 The development of a plasma fluctuation diagnostic software tool. Hong, J.Y. (Intelligent Signal Processing, Austin, TX (USA)); Powers, E.J.; Ritz, C.P. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper describes a software package that will ultimately be made available to the magnetic fusion energy community and which may be used to analyze and interpret linear and nonlinear fluctuation data generated by a wide variety of plasma diagnostics such as, for example, probes, scattering systems, and beams. The software tool is divided into two basic parts: mathematical/statistical programs will be further subdivided into those suitable for stationary and nonstationary data. The stationary data package will include bispectral analysis, a very powerful tool in the analysis of nonlinear data. Application programs will include fluctuation-induced particle transport, two-point estimates of S(k,w), three-wave coupling coefficients and energy cascading, and nonlinear digital filters.

29697 A probabilistic model for x-ray PHA data. Diesso, M. (Princeton Univ., NJ (USA)); Hill, K. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

In this paper, a mathematical model of the data produced by a single-arm x-ray pulse height analyzer (PHA) system is developed. Given an assumption on the electron temperature and density profiles, a maximum likelihood technique is applied to calculate the peak electron temperature and enhancement factor of the plasma. This method is currently being used in the analysis of x-ray data from the tokamak fusion test reactor (TFTR); sample results are presented.

29698 Experiences with delta compression of data produced by DIII. Henline, P.A. (GA Technologies, Inc., Oak Ridge, TN (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The requirements for the amount of data to be collected for each tokamak shot is rapidly increasing. This is caused by many factors, including more diagnostic experiments to put on a machine, lowering cost of electronics hardware (especially memory), and longer plasma current duration. The design goal for the DIII-D tokamak is 25 Mbytes of data per shot. In order to store the shot as one logical unit, the delta compression algorithm, is being used. Statistics on compression factors, times, and general usage are presented for actual DIII data. Data for 8, 10, and 12-bit digitizers are highlighted since this hardware is common to most sites.

29699 Magnetic-fusion data analysis at Los Alamos. Klare, K.A. (Los Alamos National Lab., NM (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The author reports on DAD, a versatile easy-to-use, easy-to-modify set of programs for data analysis and display. The physicist calls a program by its name and a few numbers, which will tell the device, shot, or operation needed. Each command invokes a separately compiled program. This allows each experimenter to write commands to display model calculations or special devices. A common set of displays include: raw and normalized signals, Thomson scattering nonlinear fits, thermocouple conversions, ion temperatures, and angles of phase-modulated signals. Multiple-device and multiple-shot displays of single-channel or quadrature signals show progressions otherwise hard to find. Some programs have three-dimensional displays with contour or surface plots. The shots available and device characteristics can be listed; analysis parameters may be shown or set. Other programs arm, trigger, or read acquisition devices. One number can define a whole series of commands. These programs use a shared library on Prime and VAX computers.

29700 The CHERS software system: A MicroVAX-based diagnostic. Lagin, L. (Princeton Univ., NJ (USA)); Arnold, N.; Davis, W.; Fonck, R.; Jaehnig, K.; Christianson, G.; Schneider, U. pp. 12 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The CHERS (charge exchange recombination spectroscopy) diagnostic is the first TFTR diagnostic to utilize a microVAX II computer for device control, data acquisition, analysis, and event-driven processing. The CHERS software system is described in this paper. It is based on a primary interactive menu-driven task, enabling the diagnostic physicist to perform interactive device control and monitoring, and calibration and control file editing, and to control automatic device setup, data acquisition, and analysis. All software is written in FORTRAN. Device control was accomplished using ORNL VAX CAMAC and RTIPS (Real time image processing system) FORTRAN subroutines. Standard VAX system services are utilized, including the use of event flags, global sections, logical names, AST's (Asynchronous System Traps), security services, and subprocess spawning.

29701 The PLT data acquisition and analysis system. Murphy, J.A.; Gibney, T.R. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The data acquisition and analysis system for PLT is discussed in this paper. It is being moved from a KL-10 to a VAX 11/785. Most of the major diagnostics are currently running on the VAX, with approximately one Mbyte of data being taken each shot. The system uses the MIT Model Data System (MDS) for acquisition and archival of data and the PPPL Event Control System (ECS) for scheduling. The analysis programs use the MDS data retrieval subroutines which deliver correctly calibrated results to the user program.

29702 Data acquisition and display in space plasma physics. Williams, D.J. (Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab.). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Studies of the behavior of space plasmas and their interactions require the acquisition and display of voluminous amounts of data: The basic data set required consists of ac and dc magnetic and electric fields and the three dimensional distribution functions for ions and electrons. The frequency, energy, and intensity ranges for these data span many decades and present a challenge to the observer to identify and understand the systematics of the data set as a whole. The data are used to characterize the plasmas encountered and their dependence on both external and internal parameters. This requires data displays which encompass long time intervals and which allow one to distinguish readily between various plasma regimes. The data also are used to study the micro-physics of the ambient plasmas and their interactions. Here displays are required to show details of the spatial and temporal evolution of the data set over short time periods. The authors present and discuss several techniques used in space plasma physics to display these large amounts of data for effective and efficient analysis and study.

29703 The use of positrons to study transport in tokamak plasmas. Surko, C.M. (AT and T Bell Labs., Murray Hill, NJ (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

It now appears to be feasible to deposit positrons (e^+) in a tokamak plasma by injecting bursts of neutral positronium atoms ($e^+ e^-$), which are then ionized by the plasma. The annihilation time of these positrons in the plasma is long compared with typical particle containment times. Thus, the subsequent transport of the positrons can then be studied by monitoring the time dependence of the annihilation, gamma radiation produced when the positrons strike a limiter. For example, by varying the initial positron deposition profile in the plasma, information about the spatial dependence of the diffusion and convection of these electron-mass charged particles can be obtained. The author discusses the design of such an experiment (including a positron trap capable of producing a single-component positron plasma), the kinds of data which can be obtained, and the physics questions which this experiment might address. This diagnostic technique could also be useful for studying transport in other magnetic confinement devices such as mirrors and reversed-field pinches.

29704 Use of the Kalman filter in signal processing to reduce beam requirements for alpha-particle diagnostics. Cooper, W.S. (Lawrence Livermore National Lab., CA (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract AC03-76SF00098. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Several techniques proposed for diagnosing the velocity distribution of fast alpha-particles in a burning plasma require the injection of a beam of fast neutral atoms as probes. The author discusses how improving signal detection techniques is a high leverage factor in reducing the cost of the diagnostic beam. Optimal estimation theory provides a computational algorithm, the Kalman filter, that can optimally estimate the amplitude of a signal with arbitrary (but known) time dependence in the presence of noise. In one example presented, based on a square-wave signal and assumed noise levels, the Kalman filter achieves an enhancement of signal detection efficiency of about a factor of 10 (as compared with the straightforward observation of the signal superimposed on noise) with an observation time of 100 signal periods.

29705 Backward compton scattering for probing electric fields in a plasma. Joshi, C. (California Univ., Los Angeles, CA (USA)); Clayton, C.E. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). Grant ECS-83-10972. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

A new method is suggested for probing ultra high electric fields associated with relativistic plasma waves in high density plasmas. A relativistic electron beam and an intense photon beam are collided inside the plasma. In the absence of any perturbing fields, the electrons Compton scatter some of the photons. In the backward direction, the frequency of the scattered radiation is roughly $4\gamma^2\omega_0$ with a frequency spread of $\sim 2\Delta\gamma/\gamma$). When strong electric fields are present, some of the electrons are accelerated and others are decelerated. This leads to broadening of the Compton scattered spectrum. An experiment designed to probe coherent longitudinal electric fields of a beat excited plasma wave is described.

29706 Barium ion beam magnetic field and space potential diagnostic. Wickham, M. (TRW Physical Sciences Center (US)); Higgins, L.; Lazar, N.H.; Dandl, R. pp. 92 of Proceedings of the 6th

topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Improvements have been made in a barium ion beam magnetic and space potential diagnostic to increase the signal to noise ratio which have made measurements in the STM hydrogen plasma possible. These improvements include larger solid angle collection optics, higher delivered laser power and higher ion beam densities. Radial profiles of magnetic field, space potential and potential fluctuations are presented for various operating conditions of the STM device. Application of this diagnostic to other plasma devices is presented.

29707 Simultaneous measurements of radial and poloidal wavenumbers using a heavy ion beam probe. Connor, K.A. (Rensselaer Polytechnic Inst., Troy, NY (USA)); Crowley, T.P. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Experimental studies of density, temperature, or potential fluctuations have been limited by the inability of the available diagnostics to determine radial and poloidal wavenumbers at the same plasma location. Laser scattering, for example, is only sensitive to the wavenumber perpendicular to the beam. Heavy ion beam probes obtain wave number information by observing two nearby locations along the beam (with two detectors) and thus are only sensitive to the wavenumber parallel to the beam. The authors report a technique under investigation that can permit the beam probe to determine both components of the wavenumber by adding a rapid, small amplitude, square wave sweep voltage modulation that moves the measurement point between two points displaced slightly from the beam axis. With four measurement points displaced along and perpendicular to the beam, k can be determined for fluctuation frequencies limited only by the beam sweep modulation and detector electronics.

29708 TEXT heavy ion beam probe. Schoch, P.M. (Rensselaer Polytechnic Inst., Troy, NY (USA)); Forster, J.C.; Jennings, W.C.; Hickok, R.L. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report on the 500 keV TEXT heavy ion beam probe, now on line. Very good signal to noise ratio has been observed during the initial operating phase. The large size and high operating energy presented some developmental problems that had not been encountered with previous beam probe systems. A 74% electrostatic beam bending system was required to direct the beam to the proper injection angle. Dual quadrupole lenses were installed to compensate for the distortion of the bending system. In order to reduce the size, the parallel plate energy analyzer is operated at a field of 10 kV/cm. The possibility of severe field distortion by UV produced photo electron current was minimized by careful baffling and the use of a parallel wire top plate. The 8 r.f. type power supplies used to drive the system can introduce coherent ripples that had to be suppressed. Experimental evidence for the existence and the suppression of these characteristics is presented.

29709 Heavy Ion beam probe diagnostic system for ATF. Carnevali, A. (Rensselaer Polytechnic Inst., Troy, NY (USA)); Misium, J.; Lewis, J.F.; Connor, K.A. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The potential structure in non-axisymmetric toroidal confinement devices is largely responsible for the particle drift surfaces. A heavy ion beam probe diagnostic, which can directly determine the potential, is thus planned for ATF. The most significant device characteristics affecting the implementation of such a system on this complex magnetic geometry that were not encountered on tokamaks are the large toroidal separation (15 degrees) of vertical and horizontal ports and substantial magnetic return fields in the region of the ion optics and energy analyzer electric fields. The status of the design is presented with particular emphasis on the choice of energy analyzer required by the large dispersion in ion trajectories produced by this field.

29710 Highly doped ruby filters for stray light reduction in Scatpak II. Thomas, E.E. (Georgia Inst. of Tech., Atlanta, GA (USA). Fusion Research Center); Kindsfather, R.R. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

A ruby crystal with doping of 1% Cr_2O_3(by weight), was grown, cut, polished and anti-reflection (AR) coated to produce high through-put filters for reducing the stray light in ruby-laser scattering experiments. These filters have a transmission better than 99% for wavelengths longer than 7000 Å with the polarization perpendicular to the c-axis. Procurement specifications and performance are presented. Performance of the filters is compared with existing theoretical work. The 4 mm thick filters attenuate stray light perpendicular to the c-axis by a factor of 9, and perform well in scattering experiments on the red side of the spectrum.

29711 Thomson scattering in the Tara tandem mirror central cell. Casey, J.A. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center); Irby, J.H. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report on a Thomson scattering experiment under construction for the central cell of the Tara tandem mirror. This experiment has been designed to measure electron temperature and density at densities down to $3 \times 10^{11} cm^{-3}$. The measurement is made at a single time-point per shot using a holobeam 10 J Q-switched ruby laser, folded back for two passes through the scattering volume. Detection is at 90 degrees with f5 optics. The optical table is mounted on linear bearings with a 10 inch stroke, so that the radius of the scattering volume may be changed from shot to shot. Features of the experiment include a high-throughput (>25%) commercial triple-grating polychrometer using holo-graphic gratings, and a directly coupled ten channel micro-channel plate photo-detector array.

29712 The TFTR edge Thomson scattering system. Grek, B. (Princeton Univ., NJ (USA)); Dimock, D.; Johnson, D.; Palladino, R.; Tolnas, E. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report on a system under construction which will provide measurements of TFTR plasma edge profiles of electron temperature and density. The edge diagnostic would make use of many of the components of the full profile systems now installed-the laser, the collection optics, the calibration and alignment hardware. It would sample signal from three adjacent fiber optic bundles of one of the two existing 76 bundle systems and send it to a spectrometer and detector which are optimized for low density, low temperature conditions. The choice of sampled positions is scannable from the inner wall to the outer wall at the horizontal midplane. Optically, the system will be able to resolve the resulting 10 cm profile into 20 spatial points and 20 spectral channels. The detector consists of a CCD intensified with an 18 mm third generation intensifier. Minimum detectable temperatures will range from 5 ev at the inner edge to 10 ev at the outer edge. With efficient background suppression the minimum density will be $5 \times 10^{11}/cm^{-3}$.

29713 Feasability study of using the TFTR Thomson scattering system for q profile measurements. Brizard, A. (Princeton Univ., NJ (USA)); Grewk, B.; Johnson, D.; LeBlanc, B. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on

high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The results of a study made to determine the possibility of using the TFTR 76 channels Thomson scattering system to measure the direction of local magnetic fields in a tokamak plasma are presented. As this is a local measurement, this technique can in principle yield q profiles without the need of any de-convolution. The effect of the TFTR geometrical configuration and its various components on the expected measurement accuracy is discussed. The authors find that the measurement of q values within the inner half of the plasma should be possible, with only minor modification to the present TVTS system.

29714 Design concepts for compact mass/energy charge exchange analyzers. Roquemore, A.L. (Princeton Univ., NJ (USA)); Medely, S.S. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Charge exchange diagnostics in a hostile neutron and gamma radiation environment require substantial shielding against radiation-induced noise signal. Minimizing the dimensions of the apparatus significantly reduces the shielding complexity. Conceptual designs for compact analyzers are presented. The reduced size is achieved primarily by employing high field strength (> 8 kGauss) permanent rare earth magnets to simplify magnetic field generation.

29715 Diagnostics for space and time resolved ion temperature measurements in the STRO-M tokamak. Van Heesch, E.J.M. (Regina Univ., SK (Canada)); Hirose, A.; Sarkissian, A.; Skarsgard, H. M. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The energy spectrum of fast helium neutrals scattered off plasma ions is a rather straight forward measure of the ion temperature. An outline is given of the experimental technique to apply this scattering method on STOR-M. The authors compare it with charge-exchange measurements using the same apparatus. The expected accuracy of the scattering technique is 10% with a time resolution of 40 μs and a radial resolution of 1 cm. The advantages of the technique originate from the relatively high energy range in which it operates. (The scattered spectrum lies just below the incident beam energy.) Therefore the scattered neutrals escape from the plasma with little attenuation and are easily distinguished from thermal neutrals. The use of helium instead of hydrogen improves the count rate considerably and decrease the number of slowing down beam neutrals.

29716 Plasma measurements with the TMX-U E||B end-loss ion spectrometers. Foote, J.H. (Lawrence Livermore National Lab., CA (USA)); Wood, B.E.; Brown, M.D.; Curnow, G.M. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report two E||B end-loss-ion spectrometers (ELIS) nowmaking plasma measurements on TMX-U. One instrument is mounted on each end of this open-ended tandem-mirror machine. These spectrometers observe plasma losses along magnetic-field lines. They operate reliably and with a minimum of attention during an experimental run. Their data, which are quickly acquired and analyzed, help guide the experimental sequence. The parallel electric and magnetic fields separate the end-loss ions according to mass (D^+ and H^+) and energy. Each spectrometer detects ions with an array of 128 flat collector plates, made from copper-coated G10 epoxy fiberglass, normally used for printed-circuit boards. The ELIS diagnostic system produces a wealth of experimental information, including data on peak plasma potential, central-cell ion temperature, potentials in the thermal-barrier region, axial confinement and ion-end-loss plugging, energetic-electron losses, and H/D concentrations.

29717 Determining plasma fueling sources with an end-loss ion spectrometers. Grubb, D.P. (Lawrence Livermore National Lab., CA (USA)); Foote, J.H. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report their use of a mass-sensitive, E||B, end-loss ion spectrometer (ELIS) mounted near the center line of TMX-U to help identify the major sources of fueling gas. They set the electric field in the ELIS to simultaneously measure the axial loss currents of both hydrogen and deuterium. They then initiated plasma discharges where we injected either hydrogen or deuterium gas into the central-cell. They also selected and deselected central-cell neutral beams that were fueled with hydrogen gas. The end-cell neutral beams were always selected and fueled with deuterium. By taking the ratio of the hydrogen end-loss current (with a known deuterium-gas fed rate), they were able to infer the effective fueling rates that were due to wall reflux, central cell beams, and end cell beams. The results were the following: wall reflux, 6 Torr x l/s; central cell beams, 20 Torr×l/s; and end cell beams, 1 Torr x l/s.

29718 A time-resolved 14 MeV neutron detector for triton confinement studies. Smith, J.R. (GA Technologies, Inc., Oak Ridge, TN (USA)); Fisher, R.K.; Leffler, J.S.; Newman, D.E. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Previous measurements of triton burnup in deuterium tokamak plasmas show an anomalously small burnup for low-q discharges with significant MHD activity. This may have important implications for alpha particle burnup in a fusion reactor. By developing a detector capable of time-resolved 14 MeV neutron measurements, it should be possible to separate triton confinement and slowdown anomalies. The authors report how they are testing lithium-free glass scintillators which would observe 14 MeV neutrons through prompt $^{28}Si(n,p)^{28}Al$ reactions. These detectors are not sensitive to the much larger 2.5 MeV neutron background and should also have less sensitivity to the large thermal neutron background when compared to conventional ^6Li-depleted glasses. Measurements of detector sensitivity to signal and potential background sources have been performed using a 14 MeV neutron source and radioactive sources. The expected signal behavior under various DIII-D plasma and beam conditions is presented.

29719 Nuclear reaction diagnostics of fast confined and escaping alpha particles. Cecil, F.E. (Princeton Univ., NJ (USA). Plasma Physics Lab.); Medely, S.S.; Nieschmidt, E.B.; Zweben, S.J. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The resonant radiative capture nuclear reactions $D(\alpha,\gamma)6Li$, $6Li(\alpha,\gamma)$ 19B and $7Li(\alpha,\gamma)11B$ are examined as diagnostics of the energy distribution of confined fast alpha particles in tokamak plasmas. Count rates for realistic Q=1 DT plasma conditions are presented and compared to expected backgrounds. The design of and preliminary results from the prototype fusion gamma ray detector on TFTR are presented. The activation reactions are similarly examined as diagnostics of escaping fast alpha particles. Where possible, count rate estimates for Q=1 DT plasmas and proposed ignition devices are presented.

29720 Detector array for the measurement of the 14.7 MeV protron emission from TFTR. Strachan, J.D. (Princeton Univ., NJ (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The author reports the magnitude of the $d(3He,p)\alpha$ fusion emission measured of TFTR by detection of the prompt losses of 14.7

MeV protons. Such measurements are useful for the determination of ^{3}He transport coefficients following short ^{3}He gas puffs, the determination of the confinement of the 0.8 MeV ^{3}He ion produced in the d(d,n)^{3}He fusion reaction and the development of escaping alpha diagnostics. The TFTR system consists of four detectors poloidally distributed along the bottom of TFTR. Each detector spatially resolves 14.7 MeV protons which are born above the detector and which grad B drift into the detector. The detectors are surface barrier detectors positioned behind 20 mil stainless steel foils which prevent soft X-ray and lower energy charged fusion products from being counted.

29721 Neutron fluctuation measurements on TFTR. Heidbrink, W.W. (Princeton Univ., NJ (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The author reports measurements of fluctuations in the neutron yield made on TFTR with plastic scintillators. Light from the scintillators is coupled through fiber optic cables to photomultipliers operated in current mode. Discrimination against hard X-rays is accomplished through comparison with the signal from a ZnS(Li^6) scintillator. These measurements are useful in studies of deuterium pellet deposition, of the acceleration of beams ions during major radial compression, and of MHD instabilities. To study the mode numbers of the instabilities, detectors are situated at different poloidal and toroidal positions. Techniques for measuring the neutral beam density profile and Q^{equiv}_{dt} using neutron fluctuation measurements during pellet injection are proposed.

29722 Silicon surface barrier detector for fusion neutron spectroscopy. Elevant, T. (Royal Inst. of Tech., Stockholm (Sweden)); Handel, H.W.; Neischmidt, E.B.; Samuelson, L.E. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper presents an investigation of the usefulness of the intrinsic ^{28}Si(n,α)^{25}Mg and ^{28}Si(n,p)^{28}Al reactions in silicon surface barrier detectors for measurements of ion temperatures in D-T fusion plasmas and of D-T fusion neutron flux. For a 14-MeV neutron-generator narrow energy-line source, the energy resolution ($\approx$1.5%), detection efficiency and useful count rates have been determined. Based on these results, for a 100 ms time bin, D-T plasma ion temperatures from 2 to 6 keV can be determined from the FWHM of the neutron-induced α spectral lines, with the error estimated to be 25% to 5%, respectively. The maximum intrinsic detection efficiency for a nominal 1500 μm thick detector is $\approx 6 \times 10^{-4}$.

29723 Neutron diagnostics on TFTR utilizing the Campbelling technique. England, A.C. (Princeton Univ., NJ (USA)); Hendel, H.W.; Neischmidt, E.B. pp. 92 of The liver - biology and pathobiology. Second edition. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report modified commercial neutron counting equipment installed on a tokamak fusion test reactor (TFTR) which utilizes the Campbelling theorem to monitor the neutron source strength at very high neutron count rates. Campbelling utilizes the large amplitude fluctuation from neutron events in the detectors to discriminate against small amplitude noise events. Source strengths yielding equivalent count rates a factor of five higher than possible in the conventional count rate mode have been obtained to date. The concept of Campbelling is discussed and the particular application to TFTR is illustrated.

29724 Effect of ion speed distribution on the spectral shape of the 2.5 MeV neutron line produced in D-D fusion. Slaughter, D.R. (Lawrence Livermore National Lab., CA (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The author discusses how ion mean energy may be determined from Doppler broadening of the 2.5 MeV neutron line on Maxwellian deuterium plasma. Since many plasmas are non-Maxwellian, an Monte Carlo simulation has been used to predict the spectral shape produced by a variety of simple speed distributions with mean energies in the range 1-100keV. The results are Gaussian to high order and their width varies as the square root of the mean ion energy. However, the line width varies substantially among different ion speed distributions with the same mean energy. The similarity in shape of these spectra prevent the determination type from detailed measurements of the neutron spectrum.

29725 A fiber sensor neutron streak camera for ICF diagnostics. Kislev, H. (Illinois Univ., Urbana, IL (USA)); Miley, G.H. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors propose a design for a neutron streak camera for ICF burn studies. It uses a fiber optic sensor so that the camera itself can be removed from the target chamber. The sensor element is based on the decreased optical transmission (darkening) of a fiber optic doped with fissile material during neutron irradiation. The prompt darkening is proportional to the electron density, i.e., to the integrated neutron flux via the integrated fission rate. Since the characteristic time constant for fission-induced secondary-electron emission is $\approx$ psec, the darkening response time should be adequate. The sensor uses a fiber optic coiled in a spiral and mounted on a thin hollow-disk centered around the target. A synchronized short UV-laser pulse is injected into the sensor fiber and outward in the spiral at a radial speed matched to the expanding neutron front. An advantage over current designs is that sensitive and costly components are removed from the intense radiation field. The authors present calculations of minimum yield requirements, darkening time response, and overall temporal resolution.

29726 Debris collection from implosion of microballoons. Prussin, S.G. (Lawrence Livermore National Lab., CA (USA)); Lane, S.M.; Richardson, M.C.; Noyes, S.G. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report the recovery of krypton from implosion of glass microballoons studied on the development of a radiochemical diagnostic for determination of $<\rho r>$ fuel. Collection onto metal surfaces following implosions performed on the OMEGA laser with 1-3 TW (1-2 kJ) of 0.35μm light is consistent with an ion implantation mechanism. The dependence of the intrinsic collection efficiency on the energy fluence to the collector surface and its variation in implosions carried out under the same nominal conditions indicate ion energies extending to at least 0.1 MeV and energy distribution functions that are sensitive to the details of the implosion dynamics. Intrinsic sticking efficiencies approaching 0.5 can obtained in the limit of total energy fluence to the collector surface ($\leq$ 0.1 cm^2).

29727 Neutron spectroscopy on Nova. Cable, M.D. (Lawrence Livermore National Lab., CA (USA)); Lane, S.M.; Lerche, R.A.; Vieira, R.G.; Prussin, S. G. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Some fundamental properties of inertial confinement fusion implosions can be measured using diagnostics based on neutron spectroscopy. An instrument that will measure neutron spectra using time-of-flight techniques with an array of single-hit detectors is being developed for use on Nova. Its initial application , measurement of ion temperature is discussed. Other potential applications, such as measurement of fuel $<\rho R>$ are also discussed.

29728 Approaches to the diagnostics of alpha particles. Zweben, S.J. (Princeton Univ., NJ (USA). Plasma Physics Lab.). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Alpha particles from D/T reactions are expected to be produced at a power level of ≃5MW in $Q \simeq 1$ beam heated experiments in TFTR. They will become the dominant heating mechanism in future tokamak ignition devices. Although alphas should be well confined in these devices according to neoclassical orbit theory, the effects of plasma instabilities on alpha confinement and the effects of alphas on plasma confinement and heating remain to be seen. For diagnostic purposes, alphas fall into three general categories: fast confined alphas, which are to be detected inside the plasma at relatively high energy (E ~ .5-3.5 Mev), slow confined alphas, which are to be detected inside the plasma but after substantial thermalization has taken place (E ≈ .01-.5 MeV), and escaping fast alphas, which are to be detected at the wall or limiter (E > .5 MeV). For escaping alphas a relatively simple scintillation detector has been built and is presently being tested on TFTR. For slow confined alphas a charge exchange recombination spectroscopy system (similar to that which has already measured thermal He^{++} in PDX and D-III) should be feasible and will be tested at $Q \simeq 1$ in TFTR. However, for fast confined alphas the diagnostic problem appears to be much more challenging, and suitable diagnostic techniques have not yet been developed. This paper reviews recent progress and prospects in these alpha diagnostic areas.

29729 Diagnostics of space plasmas. Bame, S.J. (Los Alamos National Lab., NM (USA)); Belian, R.D.; McComus; Young, D.T. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Diverse plasmas have been observed in the magnetospheres of Earth and other planets, and in interplanetary space. Recently, plasmas and fields were measured by a space probe in the coma and tail of comet Giacobini-Zinner. In the various plasma regimes of space investigated during the space era, a wide range of characteristics has been found: particle densities from < 0.01 to 1000 per cc, energies from < 1 eV to amny MeV, temperatures from < 1 eV to > 1000 eV, and bulk flow speeds from near stationary to > 1000 km per s. A wide range of plasma wave activity and instabilities characterized these plasmas. The measurements are made with a variety of instruments ranging from electrostatic analysis with time-of-flight or magnetic analysis in order to identify the ions and their charge states. This paper outlines the plasma regimes encountered in space. The authors discuss instrument design principles and constraints imposed by limited spacecraft resources, and describe some of the instruments used.

29730 Magnetic-fusion data acquisition at Los Alamos. Wilkins, R.W. (Los Alamos National Lab., NM (USA)); Klare, K.A. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors discuss the use of a single software program to acquire data from hundreds of CAMAC recorders. For the past five years, this program has been used in all of their experiments, both manual and computer controlled. A variety of signals are stored on transient digitizers and other memories. The computer retrieves the data and applies an efficient compression algorithm before storing it on disk. The physicist can plan the next shot from the acquired data even as the rest is read. The readout is list-directed with device, amplifier, and time base types and their settings selected by the physicist. A new experiment may be set up in minutes.

29731 Multi-chord, near infrared interferometers for the CTX and ZT-40M experiments. Newman, E.W. (Los Alamos National Lab., NM (USA)); Buchenauer, C.J.; Hoida, H.W. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

A versatile, multi-chord CO_2 interferometer design with a wide dynamic range is adapted to several different experiments. The systems are double-pass, Mach-Zehnder, heterodyne, interferometers that employ a single germanium Bragg cell and $2^{n+1} - 1$ (n an integer) 50% beamsplitters to produce 2^n interferometer chords, and a single reference beam with matched optical path lengths. Heterodyne signals detected with room-temperature HgCdTe photo-resistors are demodulated with digital phase detectors that can track several fringes per μsec. The real-time electron density readouts provide a considerable savings in ADC channels and computation time when compared with quadrature phase detection schemes. High reliability is achieved with a temperature controlled wave-guide CO^2 laser operating in a single mode at intermittent duty. The CTX instrument has been operating with 8 chords since March, 1984. The ZT-40M instrument, which is under construction, employs a second wavelength to correct for room vibrations in the 0.01 fringe density range.

29732 Digital complex demodulation applied to interferometry. Powers, E.J. (Texas Univ., Austin, TX (USA)); Bengtson, R.D.; Brower, D.L.; Luhmann, N.C. Jr.; Peebles, W.A.; Choi, D.; Joyce, G. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). Contract F49620-82-C-0033. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

A common problem associated with many interferometers used for plasma diagnostics is miscounting of fringes due to noise, and relatively poor time response. It is the purpose of this paper to point out that a digital technique known as complex demodulation offers an attractive alternative to analog demodulation. The detector output is digitized directly and transferred to a computer where it is demodulated by multiplying by $\exp(i\ \omega_o t)$ and digitally low pass filtering. The filter output is the desired demodulated signal. In this paper, the authors describe the digital complex demodulation technique and demonstrate its superiority by comparing it with conventional analog demodulation data obtained with an FIR interferometer on the TEXT tokamak.

29733 Study of optically thin electron cyclotron emission from TFTR using a Michelson interferometer. Stauffer, F.J. (Maryland Univ., Baltimore, MD (USA)); Boyd, D.A. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). Contract AC02-76-CH03073. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The TFTR Michelson interferometer, which is used as an electron temperature diagnostic, has a spectral range of 75-540 GHz. This range is adequate for measuring at least the first three cyclotron harmonics, and it spans both optically thick and thin portions of the ECE spectrum. During the most recent opening of the TFTR vacuum vessel, a concave, carbon reflector was installed on the back wall of the vessel, opposite the light collecting optic of the Michelson system. The reflector is designed to prevent the observation of optically thin ECE that originates from a location that is outside the field of view of the light collecting optic. If this is achieved, it should be possible to derive the electron density profile from measurements of either the extraordinary mode third harmonic or the ordinary mode second harmonic. An analysis of ECE spectra that have been measured before and after installation of the reflector is presented.

29734 Installation and calibration of a grating spectrometer for electron cyclotron emission measurements using circular waveguide. Lohr, J. (GA Technologies, Inc., Oak Ridge, TN (USA)); Johns, G.; Moeller, C.; Prater, R. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The grating spectrometer installation on the DIII-D tokamak is discussed. It uses fundamental circular waveguide propagating the TE_{11} lowest order mode followed by oversized circular guide carrying the low loss TE_{01} mode. The short section of fundamental guide permits use of an electronic chopper operating at 50 kHz for both calibration and plasma operation. By using a.c.-coupled amplifiers tuned to the chopping frequency, the background signal generated in the InSb detectors by neutrons and x-rays is automatically subtracted and the system noise bandwidth is reduced. Compared with a quasi-optical system, the much smaller fundamental horn and front end waveguide allow the entire waveguide system to be located outside a gate valve. With this configuration the entire waveguide run, including the actual horn and vacuum window used during plasma operations, can be included in the calibration set-up.

29735 Resolving the propagation direction of tokamak microturbulence via homodyne spectroscopy. Brower, D.L. (California Univ., Berkeley, CA (USA)); Peebles, W.A.; Luthmann, N.C. Jr.; Powers, E.J.; Ritz, C.P. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

A new homodyne spectroscopy technique has been applied to tokamak microturbulence measurements in order to ascertain the frequency spectra and wave propagation direction of low-frequency density fluctuations. This method has been used in conjunction with collective scattering of far-infrared laser radiation experiments on the TEXT tokamak. Application of the new homodyne spectroscopy technique provides a high resolution, inexpensive and easily implemented alternative to the more technically demanding heterodyne detection schemes typically available in the far-infrared. The authors present a comparison of heterodyne and the new homodyne spectroscopy results.

29736 An ECE diagnostic for the TARA tandem mirror machine using a fast-scanning Michelson interferometer. Guharay, S.K. (Maryland Univ., College Park, MD (USA). Lab. for Plasma and Fusion Energy Studies); Boyd, D.A.; Ellis, R.F. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The ECE diagnostic utilizes a fast-scanning Michelson interferometer to determine two parameters, the temperature and the loss-cone-angle, of the distribution function of the hot electrons ($T \gtrsim 100$ keV) generated in the axisymmetric plug plasma of the TARA tandem mirror device. The radiation transport system employs a lens relay and a low-pass grating filter in order to transmit the synchrotron radiation spectrum over a spectral range of 2.9 - 18.6^{-1}. This enables the authors to study the emitted radiation spectrum up to the 40th harmonic of the fundamental electron-cyclotron frequency in the plug plasma ($B \simeq 5$ kG). Details of the design principles and the development of the diagnostic at TARA are presented.

29737 Development of an FIR interferometer for ATF: Part II - system design. Casson, W.H. (ORNL (US)); Hutchinson, D.P. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Because of the highly elliptical cross section of the advanced toroidal facility (AFT) plasma, a large number of interferometer channels are required to determine the radial density profile by Abel inversion. The authors discuss how a 15-channel system is being developed using a single fan shaped beam through the plasma and observing the phase shift across the profile with a 15 element detector array. The laser output at 119 microns will be transmitted about 10 meters from the laser to the plasma device via an oversized dielectric waveguide. A surface grating will be used to redistribute the Gaussian power distribution to a sinc type distribution. The beam will then be expanded in one dimension and focused through the plasma. It will then be combined with the local oscillator and focused on the detector array. Commercial Schottky diodes mounted in corner cube reflectors will be used as mixers. The entire system will be controlled by computer including the lasers and the data acquisition system.

29738 Improved system for perpendicular electron-cyclotron emission measurements on TMX-upgrade. Lasnier, C.J. (Maryland Univ., Baltimore, MD (USA)); Ellis, R.F.; James, R.A. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Perpendicular electron-cyclotron emission (PECE) is used on TMX-U to diagnose thermal-barrier hot electrons (t_H - 100 to 400 keV)yielding the time history of the density and temperature of these relativistic electrons. The authors describe an improved quasi-optical viewing system for these measurements that uses high sensitivity super-heterodyne receivers at fixed frequencies of 60, 98, 130, and 195 GHz. The improved viewing and transport system consists of an off-axis ellipsoidal mirror that images the plasma onto a V-band conical collection horn, an overmoded circular waveguide ($\sim$ 7/8' diam) that transports the radiation outside the vacuum vessel where the polarization is selected, and a high absorptivity Macor beam dump to prevent internal wall reflections from entering the viewing system. A relativistic code is used to calculate optically thin PECE signals from relativistic electrons for various energy and pitch angle distributions.

29739 Alcator C vertical viewing electron cyclotron emission diagnostic. Kato, K. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center); Hutchinson, I.H. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

ECE (electron cyclotron emission) measured vertically through the center of a tokamak plasma yields detailed information about the electron velocity distribution. A diagnostic developed for this purpose on Alcator C tokamak uses specialized focussing optics to obtain a well collimated viewing chord, a compact viewing dump made of pyrex or macor to reduce the effects of wall reflection and depolarization, and a rapid scanning Michelson interferometer-InSb detector system for the spectrum measurement; all constrained by the limited access and the compact size of Alcator C. Detailed calculations behind design decisions are discussed. ECE spectra obtained by this diagnostic, as well as the results of velocity distribution analysis, are presented.

29740 A new diagnostic for spheromaks: What are the possibilities. Boyd, D.A. (Maryland Univ., Baltimore, MD (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Electron cyclotron emission from a spheromak plasma may be able to provide information about the confining magnetic field of the system. Emission generated in the extraordinary mode wit hits electric vector perpendicular to the local magnetic field at sufficiently high frequency will propagate out of the plasma while retaining the original orientation if its electric vector. Thus, a measurement of the orientation of the emergent electric vector and the emission frequency will allow one to deduce the orientation and strength of the magnetic field at the radiation source. In this paper, simple models of the Maryland spheromak are used to examine the practicality of such a diagnostic.

29741 A 137 GHz gyrotron diagnostic for instability studies in Tara. Machuzak, J.S. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center); Cohn, D.R.; Gerver, M.; Guss, W.; Mauel, M.; Mulligan, W. J.; Post, R.S.; Temkin, R.J.; Woskoboinikow, P. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma

Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report on a narrow linewidth (< 100 kHz), 1 kW, 137 GHz gyrotron and an efficient TE03 to TE11 cylindrical waveguide mode converter set (> 97% TE11 mode output) built for collective Thomson scattering diagnostics. The main goal will be to study instability driven ion density fluctuations in the Tara plug such as the drift cyclotron loss cone (DCLC), the axial loss cone (ALC), harmonics of the DCLC and ALC, and the ion two stream instability. The heterodyne receiver and signal optics have been installed on Tara. Background electron cyclotron emission (ECE) at 139 ± 1.5 GHz after electron cyclotron resonance heating in the Tara plug corresponded to equivalent blackbody temperatures of 363 and 73 eV for extraordinary and ordinary emission, respectively. The well collimated receiver field of view completely through the TAra plug has allowed for excellen polarization discrimination of the ECE. The high power capability of this gyrotron will allow weak fluctuations to be detected above this background during ECRH heating in the plugs.

29742 Measurements of waves, fields, and particles in a laboratory plasma. Gekelman, W. (California Univ., Los Angeles, CA (USA). Dept. of Physics). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). Grant NSF-Phy84-10495. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

A laboratory plasma, diagnostic probes, and data acquisition system have been designed to permit highly detailed measurements of magnetic field reconnection and wave and particle interactions. The plasma is produced with an oxide coated cathode at a 1 H_z repetition rate. Data is acquired by a system consisting of a data acquisition computer linked to a Vax computer and online array processor, by a fast network. In reconnection experiments a current sheet is established embedded between antiparallel magnetic fields. The magnetic field topology is measured at 4000 spatial locations and 1000 time steps by three orthogonal loops moveable anywhere within the plasma volume. Fully three dimensional data are presented stereo-scopically. Fluctuations of the magnetic fields are studied by correlation techniques which yield the three dimensional propagating whistlers. A highly directional velocity analyzer is used to measure the particle distribution functions at 360 angles in velocity space.

29743 Diagnostics using an injected neutral helium beam. Levinton, F.M. (JAYCOR, Albuquerque, NM (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

A diagnostic for measurement of the internal magnetic field and the ion temperature is described which is applicable to the current generation of magnetic fusion devices. The technique involves the injection of a neutral helium beam into the plasma. The magnetic field can be determined from Zeeman spectroscopy using laser induced florescence or collisional excitation of the beam. Ion temperature measurements can be made from doppler broadening of the charge exchange recombination radiation or elastic scattering of the beam particles. Details of the beam propagation through the plasma are solved numerically using a system of coupled rate equations. The diagnostic is suitable for a wide range of plasma and machine parameters. Results from computer simulations have been obtained for the S-I spheromak and TFTR which show ~ 50% of a keV beam can penetrate to the center of the plasma.

29744 Simultaneous detection of multiply charged species from a heavy ion beam probe. Jennings, W.C. (Rensselaer Polytechnic Inst., Troy, NY (USA)); Hichok, R.L.; Michael, J.D.; Saravia, E. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Two electrostatic energy analyzers are currently in use on the RENTOR beam probe system to provide detection of both 2^+ and 3^+ secondary ions. The dual analyzer detection system permits simultaneous evaluation of n_e, T_e, as well as the standard space potential measurement. Sensitivity for separating n_e and T_e is very good for electron temperatures less than 150 eV which makes this technique attractive for studying the edge regions of large tokamaks. The 500 kHz frequency response permits fast (≥1 msec) radial scans (≥25 cm) and simultaneous multi point measurement of fluctuation spectra. Separation of the observation points can be continuously varied to provide direct study of correlation lengths. Signal to noise ratio for the 2^+ measurements is greater than 3/l and for the 3^+ measurements greater than 2/l. Typical data are presented. The accuracy and sensitivity are discussed.

29745 A two-dimensional Thomson scattering system for ATF. Kindsfather, R.R. (ORNL (US)); Rasmussen, D.A.; Thomas, C.E.; Paintor, S.L.; Hays, P. S.; Morris, R.N.; Tolnas, E.L. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report a two-dimensional Thomson scattering system being designed for ATF. The system will provide electron temperature and density measurements at fifteen points along a vertical chord with each laser shot. By relocating the laser beam, and reconfiguring the input optics on subsequent laser shots, a two-dimensional electron temperature and density map of the ATF cross-section can be obtained. Translating and rotating mirrors are used to relay the light from the viewing port to a fixed focal length lens. Low temperature (2 eV to 200 eV), intermediate temperature (10 eV to 1 keV), and high temperature (20 eV to 2keV) spectrometers are used. At the output of each spectrometer dispersed light is detected by an array of five, seven, or eight photomultiplier tubes depending on the temperature range of the spectrometer. Source light will be provided by a twenty-five joule low divergence ruby laser.

29746 The PLT and PDX charge-exchange analyzers. Mueller, D. (Princeton Univ., NJ (USA)); Hammett, G.; McCune, D.C. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The perpendicularly-viewing mass-resolving charge-exchange analyzers for PLT and PDX were built to measure the plasma ion temperature, central neutral density and hydrogen to deuterium ratio. This paper discusses the measurements as they are affected by instrumental effects. In PDX with perpendicular neutral deuterium beam injection into hydrogen plasmas, a small (≈ 1%) hydrogen impurity in the beam gives rise to an energetic tail on the observed hydrogen neutral spectrum. A simple model indicates that this contamination of the thermal spectrum causes the apparent ion temperature to be 5-20% too high. This effect is included in the analysis. The neutral density measurement relies on knowledge of absolute detection efficiency. While this can in principle be measured in-situ with a diagnostic neutral beam, a large uncertainty remains. Measurement of the H/D ratio in the plasma is limited by the mass rejection (1:1000) of the analyzer. It is primarily the deuterium flux at 1/2 the hydrogen energy that places a lower limit on the measurable flux to H/D ratios above ≈ 0.5%.

29747 Multichannel Thomson scattering systems with high spatial resolution. Johnson, D.W. (Princeton Univ., NJ (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

In the last 10 years, Thomson scattering systems capable of producing single snapshot profiles of electron temperature and density with high spatial resolution (> 50 channels) have become routine diagnostics on the PLT, PDX, and TFTR tokamaks. During this period, the technology associated with these systems has advanced

on several fronts. Low divergence ruby lasers with high output energies which are stable for many months have been developed. Large area, gateable, intensified CCD detectors combined with flexible, low noise readout systems offer high sensitivity and high spatial resolution with good background suppression. Information encoded in the video field gives checks on the image justification and the laser alignment. Laser triggered sparkgaps provide failsafe detector synchronization. Stacked pyrolytic graphite blade dumps tolerate high power loads from plasma while reducing stray laser light. Concentric objective optics provide high throughput, wide angle viewing and tightly packed, coherent, low loss quartz fiber bundles alow remote sensing of the scattered signal statistics while suppressing the background component. Equally important in determining the overall accuracy of such measurements are the calibration techniques. These are described along with a catalog of profile results which demonstrate the capabilities of these systems. The author discusses how the viewing geometry of these systems also lends itself to other measurements including spatially resolved plasma emission and custom edge Thomson scatterinscattering.

29748 A double parallel-plate electrostatic analyzer for Tara endloss studies. Sullivan, J.D. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Plasma Fusion Center); Casey, J.A.; Irby, J.H.; Smith, D.K. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report on an endloss spectrograph designed and being fabricated for the Tara tandem mirror. This spectrograph is a double parallel-plate electrostatic analyzer about 60 cm in length with a 30 deg. entrance angle; the high voltage plate is a transparent wire cloth grid which allows higher energy particles to pass through for detection on a symmetric ground plane. The analyzer has three detection planes: first, the normal focal plane for low energy detection at high resolution (100eV to 4keV); second, the entrance grounded plate for mid energies (4 to 6keV); and third, the symmetric ground plane for coarse resolution at higher energies (8 to 20keV). This spectroscope will be able to measure simultaneously the endloss potential cutoff and ions from the neutral beams: in conjunction with a loss cone neutral beam source, the resolution is sufficient (60eV) to measure the plasma potential.

29749 Double scatter neutron time-of-flight spectrometer as a plasma diagnostic. Walker, S.E. (Phillips Petroleum Co., Bartlesville, OK (USA)); Preszler, A.M.; Millard, W.A. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The energy and flux measurement of D-D and D-T fusion neutrons provides a nonperturbing probe of plasma performance. In particular, ion temperature distribution of the plasma can be determined. This information can distinguish neutron production mechanisms, i.e. knock-on or thermonuclear in origin. To perform a fast neutron measurement, a high data rate double scatter spectrometer has been developed. This allows for a definitive measurement of the flux, energy, angle, and time distributions of neutrons from within the plasma. In addition, x-ray discrimination can be achieved from the time-of-flight information. The specific design issues and performance of the spectrometer are described.

29750 Measurements of mildly relativistic electron distribution functions during lower hybrid heating. Hutchinson, I.H. (Massachusetts Inst. of Tech., Cambridge, MA (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Heating and current-drive by Landau damping of LH waves on electrons creates energetic tails on the distribution function whose form determines the wave power deposition and any current generated. Therefore, experimental investigation of these tails is of significance for understanding the details of the heating/current-drive performance. The author reports progress made towards a detailed diagnosis of the energetic electrons by two complementary techniques: x-ray emission due to Bremsstrahlung, and electron cyclotron emission. The x-ray diagnosis takes advantage of the relativistic beaming of radiation in the forward direction to obtain information on the electron distribution-function-anisotropy from measurements along different viewing directions. Fits of 3-or4-parameter model distributions reveal the strong forward/backward asymmetry of current-drive plasmas and the difference between parallel and perpendicular tail temperatures. The electron cyclotron emission, when viewed along a chord of constant magnetic field (i.e. vertically in a tokamak), arises from electrons whose cyclotron frequency has been down-shifted by the relativistic mass shift. There is therefore a one-one relationship between wave frequency and electron energy, provided cyclotron harmonic overlap is negligible.

29751 Two-dimensional tokamak density distribution measurements using phase-imaging interferometry. Doyle, E.J. (California Univ., Berkeley, CA (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Conventional interferometer systems used on fusion devices are typically limited to approximately 10 channels/views. This precludes the use of tomographic reconstruction techniques. Instead, a priori assumptions have to be made as to the form of the electron density distribution. To overcome these problems interferometer systems have been developed which use imaging techniques to provide many channels per probe beam, allowing a greatly increased total number of channels to be provided. Using a two-dimensional, forty channel, imaging FIR interferometer measurements have been made of the density distribution in the minor cross-section of the Microtor tokamak. The heterodyne interferometer consists of two probe beams expanded so as to completely fill orthogonal views of the plasma cross-section. These views are then imaged onto two, twenty channel, linear microbolometer detector arrays. The line integrated phase information obtained from this system is analyzed using tomographic techniques so as to recover the spatial electron density distribution in the plasma. Density contours obtained on the Microtor tokamak are presented. They show the startup phase, hollow profiles and the effect of reducing the number of analyzed channels.

29752 Data-base tools for enhanced analysis of TMX-U data. Stewart, M.E. (Lawrence Livermore National Lab., CA (USA)); Carter, M.R.; Casper, T.A.; Meyer, W.H.; Perkins, D.E.; Whitney, D.M. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors use a commercial data-base software package to create several data-base products that enhance the ability of experimental physicists to analyze data from the TMX-U experiment. This software resides on a Dec-20 computer in M-Divisions's user service center (USC), where data can be analyzed separately from the main acquisition computers. When these data-base tools are combined with interactive data analysis programs, physicists can perform automated (batch-style) processing or interactive data analysis on the computers in the USC or on the supercomputers of the NMFECC, in addition to the normal processing done on the acquisition system. One data-base tool provides highly reduced data for searching and correlation analysis of several diagnostic signals for a single shot or many shots. A second data-base tool provides retrieval and storage of unreduced data for detailed analysis of one or more diagnostic signals. The authors report how these data-base tools form the core of an evolving off-line data-analysis environment on the USC computers.

29753 Zone plate imaging of neutrons emitted from a laser fusion target. Lerche, R.A. (Lawrence Livermore National Lab., CA (USA)); Lane, S.M.; Hawryluk, A.M.; Ceglio, N.M. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma

diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report on zone plate coded imaging techniques, routinely used to image non-penetrating emissions from laser fusion targets. Only highly penetrating radiations like 14-MeV neutrons will escape the dense compressed core region of future targets to provide information about the burn region. A zone plate for 14-MeV neutrons must be several centimeters thick to produce adequate modulation in the coded image. Computer modeling of zone plate systems show that a thick, tapered zone plate acts like a thin zone plate for points within its field of view and depth of field. Equations developed for thin zone plate systems that describe quantities such as planar and tomographic resolution may be applied to thick zone plate systems. System simulations of a 100-zone, 5-cm-thick zone plate with 5-μ outer zone width constructed of alternating layers of gold and aluminum produce images with 10-μ resolution. The source strength required to image a 20-μ diameter source is 100 to 1000 times less than that needed with an equivalent pinhole system.

29754 The injected internal target technique, (IT)^2, for hot electron diagnostics. Moses, K.G. (JAYCOR, Albuquerque, NM (USA)); Quon, B.H.; Divergilio, W.F. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

A neutral Xe atom beam injected into a hot electron plasma will generate enhanced x-ray emission locally in the path of the beam by bremsstrahlung and K-Shell ionization processes. A collimated x-ray detector system analyzes the energy distribution of the photons emitted by the beam atoms inside the volume occupied by the plasma. From the slope of photon intensity vs photon energy data, one can determine the local electron temperature, from the photon intensity of the Kα emission, one can obtain the local hot electron density. The measurement requires a high quality heavy atom beam with effective current densities $\approx$ 50 mA/cm^2 at ~50 keV energy. The design and test results of the beam system are presented.

29755 Detection limits in the measurement of alpha particles by CO_2 laser Thomson scattering. Richards, R.K. (ORNL (USA)); Hutchinson, D.P. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

It is found for plasma conditions expected during ignition studies ($n_e \sim 10^{14}$cm $^{-3}T_e \sim$10 keV) that alpha particle densities as low as 10^{11}cm^{-3} can be measured with CO_2 laser Thomson scattering. This detection limit is discussed. It is set by the background signal from the electrons and will change with the plasma conditions, increasing for increasing electron temperature and decreasing for increasing electron density. The effect of the B-field in producing a spatially concentrated alpha particle signal does lead to an improvement in detecting the alpha particles over the electrons. However, this improvement is typically only a factor of two or three. The reason for such a minimal improvement is that a large detector bandwidth (required for heterodyne detection) broadens the B-resonance. The principal effect of the B-field is to greatly reduce the area needed for detection.

29756 Design of a high power long pulse CO_2 laser for alpha particle Thomson scattering. Hutchinson, D.P. (ORNL (USA)); Vander-Sluis, K.L. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-8603224–: 52. Melchett lecture, London (UK), 6 Mar 1986).

A high power CO_2 laser is being constructed to measure the velocity distribution of alpha particles in a burning plasma. The laser system is being designed around a Lumonics 602 TEA CO_2 laser. A low-pressure cell will be placed in the unstable resonator cavity to produce a long-pulse, narrow-linewidth beam. Details of the laser design are presented.

29757 High time resolution temperature profile measurements on PBX. Gammel, G.; Fonck, R.; Kaita, R. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Ion temperature profiles with a time resolution of 2-5 ms have been measured on PBX by charge exchange recombination spectroscopy (CXRS) and a neutral particle charge exchange analyzer (NPA). The sightlines of both diagnostics crossed the trajectory of a near-perpendicular heating beam, which enhanced the local neutral density (A signal strength) and provided spatial resolution. The time resolution of these two independent techniques is sufficient to see sawtooth oscillations and other MHD activity. The NPA results, with the contribution from the slowing-down heating beam particles subtracted, are compared with CXRS. Effects of these phenomena on the toroidal rotation velocity profile, vϕ (r), are clearly observed by CXRS. For example, a sharp drop in the central vϕ occurs at the sawtooth crash, followed by a linear rise during the quiescent phase. The techniques are described and sources of error are described.

29758 Charge conversion of alphas by refueling pellets. Gerdin, G. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

In this paper, the neutral gas surrounding a refueling pellet is considered as a charge changing medium for diagnostics of alphas below 1 MeV. Alphas may be neutralized so they escape the system entirely or excited He^+ states can be created by electron capture and the doppler-shifted radiation observed. The neutral-shielding model was used to obtain radial profiles of neutral and plasma density and temperature surrounding the pellet. This model predicts plasma densities and temperatures in the collar plasma surrounding the pellet consistent with experiment. Conditions for a pellet injected into TFTR during a 33.5 MW neutral beam pulse are taken from a simulation. For such conditions ion and electron impact ionization in the collar plasma reduce the escape probability below 10^{-7} and n_α must be $\approx 10^{11}$/cm^3 for the doppler-shifted radiation near 1640 Å to be equal to the free-bound bremsstrahlung from the collar plasma.

29759 Scintillation detector for escaping alphas and tritons in TFTR. Zweben, S.J. (Princeton Univ., NJ (USA). Plasma Physics Lab. (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The author describes a diagnostic for escaping charged fusion products presently being tested on TFTR. It consists of a 1" x 1" ZnS scintillator screen located inside a movable probe at the bottom of the TFTR vacuum vessel. Escaping 3.5 MeV alphas or 1.0 MeV tritons are first collimated by four separate 1mm aperatures and passed through ~3μ Al foils used to block plasma light and low energy plasma. These pulses are then optically coupled to PM tubes and/or an intensified video camera for recording and analysis. First tests will include checks of the neutron and gamma backgrounds (made with one channel with a foil which stops all alphas), and observations of the measured vs. expected particle flux vs. plasma current, toroidal field, etc.

29760 Application of coincidence techniques to fusion product measurements. Murphy, T.J. (Princeton Univ., NJ (USA). Plasma Physics Lab. (USA)); Heidbrink, W.W.; Strachan, J.D. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

A technique is described in which the two products of a fusion reaction are measured in coincidence. Measuring the energies of

both particles allows the energies of the reacting ions to be calculated. The difference in the arrival times of the two particles at their respective detectors yields the difference in the path lengths from birth location to detector, and can be used to identify the location of the fusion reaction. The technique can be used to measure the spatial distribution of the full-, half-, and third-energy components of a high-energy neutral deuterium beam and the spatial distribution of the reactions in a magnetic fusion device. Possible detector arrays and sample count rates have been evaluated for $d(d,n)^3He$ reactions in TFR, for $d(t,n)\alpha$ reactions in TFTR, and for d(d,p)t reactions in the TFTR neutral beam lines.

29761 **A neutron calorimeter as a fusion diagnostic.** Proctor, A.E. (Idaho National Engineering Lab., Idaho Falls, ID (USA)); Harker, Y.D.; Neischmidt, E.B. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract AC02-76CH03073. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

A calorimeter is described which is applicable as a fusion neutron diagnostic. The advantages of the device are discussed, including: low sensitivity to thermal neutrons, no heat loss to surroundings, large dynamic range, small mass resulting in fair time resolution, and small physical size. The heat generation is provided by neutron induced fissions in a foil of ^{238}U and a calorimeter is isothermal. The effects, advantages and disadvantages of other target materials are discussed. Also discussed are time resolution and calibration.

29762 **Analysis programs and standardization of the neutron activation system at TFTR.** Neischmidt, E.B. (Idaho National Engineering Lab., Idaho Falls, ID (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract AC02-76CH03073. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The recently installed neutron activation system at the TFTR has been calibrated and the analysis programming largely completed. Data analysis programs are available on an on-line aquisition-analysis system or off-line on a VAX system. Analysis techniques include random and coincident summing corrections as well as finite source size correction at close geometries. Detector efficiency determinations also use these corrections. The application of these corrections to efficiency measurements is discussed. Also discussed are the various types of fits to gamma-ray data encountered using the neutron activation system.

29763 **Neutron diagnostics of compressed ICF targets.** Richardson, M.C. (Rochester Univ., NY (USA). Lab. for Laser Energetics); Keck, R.; Letzring, S.A.; McCrory, R.M.; McKenty, P.; Roback, D.; Soures, J.M.; Verdon, C.P.; Lane, S.M.; Prussin, S. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract FC08-85DP40200. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The final stages in the compression of microencapsulated DT fueled ICF targets require detailed characterization of meaningful comparison with predictions of hydrodynamic codes. The determination of such parameters as the fuel and shell areal densities, the average ion temperature, and the impact of implosion nonuniformities in high density target implosions present a strong challenge. The authors describe several approaches utilizing the self-generated neutrons, to diagnosing these conditions, including neutron spectrometry neutron activation of tracer gas and shell materials, and neutron scattering techniques. The importance of making simultaneous measurements of several core parameters to limit ambiguity in interpretation is discussed.

29764 **Development of an FIR interferometer for ATF: Part I - high power FIR laser development.** Casson, W.H. (ORNL (USA)); Hutchinson, D.P. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report on an FIR interferometer system for the advanced toroidal facility (ATF) developed with some major modifications to previous designs. Due to the highly elliptical cross section of the plasma and the projected plasma densities a 15 channel interferometer was designed to operate at 119 microns. The large number of channels necessitated the construction of a high power FIR laser with a fundamental mode Gaussian output over 500 milliwatts. Laser stability has been improved. The final design of the pump laser is modular to the extent that any single optical component can be removed and replaced without changing the optical alignment. The FIR cavity was modified by changing to a smaller bore, using gold coated end mirrors, and using curved internal reflectors. The addition of buffer gas to the cavity provided significant improvement in output power.

29765 **High power, twin frequency FIR lasers for plasma diagnostic application.** Lehecka, T.; Savage, R.; Dworak, R.; Peebles, W.A.; Luhmann, N.C. Jr. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The development of imaging interferometry and multichannel heterodyne scattering systems for fusion plasma diagnosis has dicated the development of high power, stable twin frequency sources in the 100 $\mu m \rightarrow$ 1000 μm spectral region. Output powers of 500mW (185 μm), 150mW (393 μm), 100mW (496 μm), and 25mW (1.22mm) have been measured directly on a calorimeter applying no correction factors. These powers have been achieved via the optimization of the CO_2 and FIR laser cavities together with the use of buffer gases (to relative bottlenecking) and variation of the pumped molecular gas temperature (to optimize the groundstate population). The source IF jitter on twin frequency FIR laser systems has also been investigated in detail. The effect of CO_2 and FIR feedback on the IF frequency has been studied with the view of producing low cost stable laser systems without complicated active stabilization. A comparison between a novel twin frequency laser involving a single optical cavity and a conventional system involving two separate cavities has been performed. The conclusions from these studies are discussed. They have been utilized in the design of laser systems operational on the TEXT tokamak and at UCLA.

29766 **Test-particle simultions of Fermi acceleration of electrons at quasiperpendicular shocks.** Gisler, G. (Los Alamos National Lab., NM (USA)). pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

This work concerns a type of first-order Fermi electron acceleration accociated with quasiperpendicular shocks. Ion-scale transverse waves in the magnetic field upstream of the shock do not scatter electrons because the field remains nearly constant on electron scale lengths. However, when these waves are advected into the shock, the leading edges are compressed first, producing mirror points for a large fraction of the electrons. Thus a population of electrons is trapped in a flux tube between two such mirror points that converge together as the field continues to advect into the shock. A similar trap is formed when straight field lines are advected into a concave region of a corrugated shock. In either case, the population is longitudinally accelerated by compression between converging mirrors. The acceleration is limited by (1) the acceleration of an electron into the loss cone, (2) the passage of the shock past the trapped flux tube, and (3) the scattering of an accelerated electron to a perpendicular momentum large enough to allow its gyrotropic escape from the flux tube. A few electrons, having special initial conditions, can be accelerated by this means to energies thousands of times greater than their injection energies. Starting from a Maxwellian distribution of initial energies, the resulting particle energy spectrum is a mildly heated (factors of two to five) Maxwellian plus a power law to very high energies with an index – 2.6 Test-particle simulations of this process are done for

parameters appropriate to the Earth's bow shock and for supernova-remnant parameters.

29767 **Microwave tokamak experiment (MTX) status and plans.** Hooper, E.B. (Lawrence Livermore National Lab., CA (USA)); Allen, S.L.; Brown, M.D.; Byers, J.A.; Casper, T.A.; Fenstermacher, M.E.; Foote, J.H.; Futch, A.H.; Hwang, D.; Lasnier, C. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The MTX program has focused on ohmic operation of the tokamak (Alcator-C moved from MIT), construction of the free-electron laser (FEL) microwave source and quasi-optical transport system, and preparation for the first measurements of absorption. The first microwave pulses from the FEL to the tokamak are planned for this spring. Measurements of the absorption of single high peak power pulses (140 GHz, 2 GW, 20 ns) will be done through September. Starting in October 1989, the FEL will be upgraded to generate pulses at 5 kHz for 10 ms, providing an average power 0.5-1 MW. A year later, the system will be further upgraded to 250 GHz and 2 MW average power. Following the upgrade to multiple-pulse operation and subsequent absorption measurements, experiments on heating and transport will be carried out. Attention will be directed to heating in peaked density profiles generated by pellet injection and to the effects of varying the power deposition profile. Plans include heat-pulse experiments and other measurements of local transport. Density fluctuations will be monitored by forward scattering of the far-infrared interferometer beams. Longer-term plans include noninductive current drive and MHD control and are outlined.

29768 **$\tilde{K}_e$ analysis and propagation direction sensitivity of HIBP data from TEXT.** Heard, J.W. (Rensselaer Polytechnic Inst., Troy, NY (USA)); Crowley, T.P.; Schoch, P.M.; Connor, K.A.; Hickok, R.L.; Yang, X.Z. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The heavy ion beam probe (HIBP) makes localized measurements of density and potential fluctuations in TEXT using a two point measurement scheme, the data can be analyzed to determine the average wavenumber, $\bar{K}$, and the cross-correlation of the signals at the two points. The authors intend to present minor radius and line averaged density scaling of $\bar{K}$. The motivation is to evaluate the feasibility of the HIBP to achieve a spatially resolved measurement of two distinct waves propagating in opposite diamagnetic drift directions. First, a simulation of the two wave model will be presented to show if correlation time analysis can distinguish the two modes. Analysis of actual data is presented with comparison of the calculated $\bar{K}$ component with theory to obtain an accurate heat transport estimate.

29769 **Theory and measurements of electrophoretic effects in monolith, fixed-bed, and fluidized-bed plasma reactors.** Morin, T.J. (Idaho Univ., Moscow, ID (USA). Dept. of Chemical Engineering). pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Pressure gradients and secondary flow fields generated by the passage of electrical current in a d.c. gas discharge or gas laser are topics of longstanding interest in the gaseous electronics literature. These hydrodynamic effects of space charge fields and charged particle density gradients have been principally exploited in the development of gas separation and purification processes. In recent characterization studies of fixed-bed and fluidized-bed plasma reactors several anomalous flow features have been observed. These reactors involve the contacting of a high-frequency, resonantly-sustained, disperse gas discharge with granular solids in a fixed or fluidized bed. Anomalies in the measured pressure drops and fluidization velocities have motivated the development of an appropriate theoretical approach to, and some additional experimental investigations of electrophoretic effects in disperse gas discharges. In this paper, a theory which includes the effects of space charge and diffusion is used to estimate the electric field and charged particle density profiles. These profiles are then used to calculate velocity fields and gas flow rates for monolith, fixed-bed, and fluidized-bed reactors. These results are used to rationalize measurements of gas flow rates and axial pressure gradients in high-frequency disperse gas discharges with and without an additional d.c. axial electric field.

29770 **Microwave absorption diagnostics on the MTX Tokamak.** Meassick, S. (Lawrence Livermore National Lab., CA (USA)); Hooper, E.B.; Rice, B.; Stallard, B.; Brooksby, C.; Veboncover, J.; Marinak, M.; Lorbeck, J. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The microwave Tokamak Experiment (MTX) is designed to investigate nonlinear Electron Cyclotron Heating (ECH) heating resulting from short, high-power, microwave pulses incident upon a high-density ($10^{14}cm^{-3}$) and high temperature (1 keV) Tokamak plasma. The Free Electron Laser (FEL) used to supply the microwave pulses will initially operate in a single pulse mode at a frequency of 140 GHz with pulse lengths of approximately 20 ns at a power of 1 - 2 GW. Ultimately the FEL will supply pulse trains consisting of 50 pulses of 50 ns duration at a power of 8 GW. The energy supplied by the FEL pulse ($\approx$ 40 J) is small compared with the stored energy of the plasma ($\approx$ 2500 J) making it difficult to elevate the beam-plasma interaction by measuring bulk plasma parameters for these initial experiments.

29771 **Time resolved XUV spectroscopy from highly ionized capillary discharges.** Rocca, J.J. (Colorado State Univ., Fort Collins, CO (USA). Dept. of Electrical Engineering); Marconi, M.C.; Muniz, M.V.; Beethe, D.C.; Schmerge, J.F. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). Grant ECS-8606226. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Pulsed capillary discharges can produce highly ionized plasmas and have been used as spectroscopic sources in the study of multiple ionized species and in the generation of X-ray radiation. The authors proposed the use of a fast capillary discharge plasma as a medium for the amplification of extreme ultraviolet radiation following electron ion recombination. They have made time resolved measurements of the axial emission from capillary plasmas 500 μ, in diameter and several cm in length excited by short (50-100 ns FWHM) discharge pulses. The use of a gated dual plate intensified array detector provides the sensitivity required to obtain extreme ultraviolet spectra with 5 ns resolution in a single discharge shot using a 1 m focal length vacuum spectrograph. Analysis of the axial spectra from a 500 μ m diameter lithium hydride capillary shows simultaneous line emission from highly ionized (LiIII, OVI) and single ionized (OII) species. The data indicates the existence of a hot core plasma surrounded by a significantly cooler plasma near the walls.

29772 **Propagation of high power microwave pulses in the air.** Kuo, S.P. (Polytechnic Univ., Farmingdale, NY (USA). Weber Research Inst.); Zhang, Y.S. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). Grant AFOSR-85-0316. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The authors report on the propagation of high power microwave pulses through the air. The dynamic behavior of the pulse propagation depends on the intensity, frequency, and width of the pulse and subjects to the physical processes occurred during the interaction of the pulse with the air. In particular, air breakdown through interaction produces ionization phenomena that can radically modify wave propagation. Ionization gives rise to a space-time dependent plasma which attenuates the tail of the pulse but hardly

affects the leading edge because of the finite time for the plasma to build up. A mechanism which is called tail erosion plays the primary role in limiting transmission of pulse. Moreover, the nonlinear and non-local effects brought about by the space-time dependent plasma also play important roles in determining the propagation characteristics of the pulse. An experiment effort to single out these characteristics is discussed.

29773 Bragg scattering of EM Waves by microwave produced periodic plasma layers. Zhang, Y.S. (Polytechnic Univ., Farmingdale, NY (USA). Weber Research Inst.); Kuo, S.P. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, New York, NY (USA) (1989). Grant AFOSR-85-0316. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Uses of artificial plasma layers as Bragg reflectors for applications in telecommunication links and over-the-horizon (OTH) radars are investigated in a large chamber made of 2 feet cube of plexiglass. In this experiment, two microwave beams at right angles to each other are directed through the S-band horns into the chamber containing air at a pressure comparable to the upper atmosphere (~ 50 Km). Inside the chamber, the microwave beams produce a series of equally spaced plasma layers parallel to the plane bisecting the two beams. A third beam is then incident onto the plasma layers and the reflected signal is collected for analysis. In this experiment, the microwave power for plasma generation is produced by a single magnetron tube with 1 MW peak output power at a frequency of 3.2 GHz. A sweep microwave generator (4-8 GHz) is used to generate a test wave which is incident into the chamber through a C-band horn. The experiment results are found to agree well with the theory.

29774 Characterization of aluminum x-pinch plasmas driven by the 0.5 TW Lion accelerator. Qi, N. (Cornell Univ., Ithaca, NY (USA). Lab. of Plasma Studies); Hammer, D.A.; Kalantartar, D.H.; Noonan, W.A.; Rondeau, G.; Workman, J.B.; Richardson, M.C. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). contract NOOO14-85-K-0212. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The x-pinch, obtained by crossing two fine wires at one or more points as the load for the 0.5 TW Lion accelerator, has been used as a bright x-ray source. High density and temperature hot spots are observed at the crossing point(s). From these hot spots, an intense, spatially confined burst of x-rays is emitted which can serve as a pump for resonant photo-pumping lasers. The authors present experimental results concerning the radiation emission using Al x-pinches. The optimum mass loading for different ionization stages of Al ions and the total x-ray energy yields are examined. The density and temperature of the plasma and the size of the hot spots are measures. Based upon the results of these experiments, the authors evaluate resonant photopumping schemes such as those involving Be-like ions, using the Al x-pinch emission as the pump source.

29775 X-ray gated images of imploding microballoons. Brandley, D.K. (Rochester Univ., NY (USA). Lab. for Laser Energetics); Delettrez, J.; Jaanimagi, P.A.; Marshall, F.J.; Verdon, C.P.; Kilkenny, J.D.; Bell, P. pp. 354 of High speed photography, videography, and photonics VI. Stradling, G.L. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract FC08-85DP40200. (CONF-8808220–: High speed photography, videography, and photonics VI, San Diego, CA (USA), 15-17 Aug 1988).

Report on a four-frame, fast gated microchannel plate x-ray detector used on the OMEGA laser system to obtain two-dimensional, time-resolved pinhole camera images (in the 1-2.5 keV region) of imploding laser fusion targets. The camera, which frame has a frame time less than 150 ps has proven to be a valuable tool, both in recording implosion dynamics and in detecting and identifying implosion non-uniformities.

29776 Characterization of gated microchannel plate x-ray imaging systems. Power, G. (Lawrence Livermore National Lab., CA (USA)); Bell, P. pp. 354 of High speed photography, videography, and photonics VI. Stradling, G. L. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). DOE Contract W-7405-ENG-48. (CONF-8808220–: High speed photography, videography, and photonics VI, San Diego, CA (USA), 15-17 Aug 1988).

Gated X-ray microchannel plate detectors and images have become very useful and reliable diagnostics on Nova. The authors have characterized these stripline instruments with respect to gain, temporal and spatial resolution. Pulse shapers (2 kV - 100 ps) and improvements in pulse propagation allow us to gate x-ray events at 100 ps. They describe new ideas in diagnostics and new methods of improving temporal resolution (<100 ps).

29777 Nanosecond framing photography for laser-produced interstreaming plasmas. McLean, E.A. (Science Applications International Corp., McLean, VA (USA)); Ripin, B.H.; Stamper, J.A.; Manka, C.K.; Peyser, T.A. pp. 354 of High speed photography, videography, and photonics VI. Stradling, G.L. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). (CONF-8808220–: High speed photography, videography, and photonics VI, San Diego, CA (USA), 15-17 Aug 1988).

Using a fast-gated (120 psec-5 nsec) microchannel-plate optical camera (gated optical imager), framing photographs have been taken of the rapidly streaming laser plasma (~ 5×10^7 cm/sec) passing through a vacuum or a background gas, with and without a magnetic field. Observations of Large-Larmor-Radius Interchange Instabilities are presented.

29778 Dilatation dissipation: The concept and application in modeling compressible mixing layers. Zeman, O. (Center for Turbulence Research, Stanford University, Stanford, California 94305-3030 (US)). *Physics of Fluids A (USA)*, 2(2): 178-188 (Feb 1990). DOE Contract AC02-78ET51013.

In this paper a concept of dilatation dissipation ϵ_d for high Reynolds number compressible turbulence is introduced. The concept is predicated on the existence of shocklike structures embedded within energetic turbulent eddies. A parametric expression for ϵ_d is found that contains calculable parameters of a turbulent field: turbulence energy and length scale, rms (turbulent) Mach number, and the kurtosis of the fluctuating velocity. The dilatation dissipation is incorporated in a second-order closure model for compressible mixing layers and model predictions of mean and turbulence quantities are presented and, where possible, compared with experiments. It is shown that the model is capable of predicting the reduction of layer growth rates as a function of the convective Mach number M_c in accordance with Papamoschou–Roshko experiments; the computations are also shown to compare well with available measurements of Reynolds stresses at M_c=0.5–0.86. Finally, the physical implications of the new model and results obtained are discussed and compared with other existing explanations of the Mach number effect on mixing layer dynamics.

29779 Whistler instability in an electron-cyclotron-resonance-heated, mirror-confined plasma. Garner, R.C. (Plasma Fusion Center, Massachusetts Insitute of Technology, Cambridge, Massachusetts 02139 (US)); Mauel, M.E.; Hokin, S.A.; Post, R.S.; Smatlak, D.L. *Physics of Fluids B (USA)*, 2(2): 242-252 (Feb 1990). DOE Contract AC02-78ET51013.

The warm-electron-driven (2 keV) whistler electron microinstability [Phys. Rev. Lett. **59**, 1821 (1987)] of the Constance *B* electron-cyclotron-resonance-heated (ECRH), quadrupole mirror-confined plasma experiment has been studied. Experiments show (i) that the instability comes in fairly regular bursts on axis and continuously in time off axis due to the minimum-*B* geometry, (ii) a frequency spectrum that is insensitive to changes in the plasma parameters, and (iii) instability-induced power losses which are not greater than 10% of the ECRH power input for the regimes studied. A linear perturbation analysis of the relativistic Vlasov equation together with Maxwell's equations has been made. Using the ECRH distribution function, a new distribution function well suited for describing ECRH, mirror-confined plasmas, the analysis shows the instability frequency spectrum to be insensitive to changes in cyclotron frequency, temperature, and density, in agreement with experimental results, and only sensitive to changes in ECRH frequency.

29780 Emission of ion and electron cyclotron harmonic radiation from mode conversion layers. Cho, S. (Department of Physics, Auburn University, Auburn, Alabama 36849 (USA)); Swanson, D.G. *Physics of Fluids B (USA),* 2(2): 235-241 (Feb 1990). DOE Contract FG05-85ER53206.

The asymmetry of cyclotron radiation from a mode conversion layer is presented for harmonics of the ion cyclotron frequency and the second harmonic of the electron cyclotron frequency for weakly relativistic electrons. The same form of Kirchhoff's law is found for all cases, relating the emission along each branch to the absorption of an incident wave along the corresponding branch. Results show that the fast wave radiation is more strongly asymmetric at the third harmonic than at the second harmonic of the ion cyclotron frequency, while the slow wave radiation ratio is about same. At the second cyclotron harmonic of weakly relativistic electrons, the asymmetry of radiation is found to be small at high temperature. The effect of equilibrium Bernstein wave radiation is also discussed.

29781 Theory of neoclassical pressure-gradient-driven turbulence. Kwon, O.J. (Institute for Fusion Studies, The University of Texas at Austin, Austin, Texas 78712 (USA)); Diamond, P.H.; Biglari, H. *Physics of Fluids B (USA),* 2(2): 291-301 (Feb 1990). DOE Contract FG05-80ET53088;FG03-88ER53275.

The nonlinear evolution and saturation of neoclassical pressure-gradient-driven turbulence (NPGDT), evolving from linearly unstable bootstrap-current modes, are investigated. The theoretical model is based on "neoclassical magnetohydrodynamic (MHD) equations" that are valid in the banana-plateau regimes of collisionality. Modes with poloidal wavelengths shorter than radial wavelengths are shown to be suppressed. From nonlinear saturation conditions, the turbulent pressure diffusivity is determined as an eigenvalue of the renormalized equations. Levels and radial scales of turbulence are determined from the pressure diffusivity and are shown to exceed mixing-length estimates by powers of a nonlinear enhancement factor. The problem of the electron heat transport resulting from stochastic magnetic fields driven by NPGDT is revisited. The reconsideration of the radial structure of magnetic flutter leads to estimates of the electron heat transport and magnetic fluctuation levels that differ qualitatively and quantitatively from previous calculations.

29782 Auxiliary heated detached plasmas in tokamaks. Guzdar, P.N. (Laboratory for Plasma Research, University of Maryland, College Park, Maryland 20742 (US)); Liu, C.S. *Physics of Fluids B (USA),* 2(2): 324-328 (Feb 1990).

Earlier studies on Ohmically heated plasmas have been extended to auxiliary heated detached plasmas in tokamaks. Assuming the electron energy loss channel to be the dominant one and caused by η_e modes, the effect of auxiliary power in determining the thermal equilibria of detached plasmas is examined. Specific predictions for central electron temperature, core plasma radius, and electron energy confinement time as a function of the auxiliary power for the tokamak fusion test reactor (TFTR) [J. Nucl. Mater. **145**, 186 (1987)] parameters are obtained. Density limit enhancement by auxiliary power is also studied.

29783 Anisotropic distribution function of minority tail ions generated by strong ion-cyclotron resonance heating. Chang, C.S. (Courant Institute of Mathematical Sciences, New York University, 251 Mercer Street, New York, New York 10012 (USA)); Colestock, P. *Physics of Fluids B (USA),* 2(2): 310-317 (Feb 1990). DOE Contract AC02-76CH03073;FG02-86ER53223.

The highly anisotropic particle distribution function of minority tail ions driven by ion-cyclotron resonance heating at the fundamental harmonic is calculated in a two-dimensional velocity space. It is assumed that the heating is strong enough to drive most of the resonant ions above the ion–electron critical slowing-down energy. Simple analytic expressions for the tail distribution are obtained for the cases when the bounce-averaged quasilinear heating coefficient D_b is assumed to be constant in pitch angle and energy, when the Doppler effect is sufficiently large to flatten the sharp pitch angle dependence in D_b but the energy dependence is allowed, and when the sharp pitch angle dependence is retained. It is found that a simple constant-D_b solution can be used instead of the more complicated velocity-dependent-D_b solutions for many analytic purposes.

29784 Toroidal microinstability studies of high-temperature tokamaks. Rewoldt, G. (Princeton Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08543 (USA)); Tang, W.M. *Physics of Fluids B (USA),* 2(2): 318-323 (Feb 1990). DOE Contract AC02-76CH03073.

Results from comprehensive kinetic microinstability calculations are presented, showing the effects of toroidicity on the ion temperature gradient mode and its relationship to the trapped-electron mode in high-temperature tokamak plasmas. The corresponding particle and energy fluxes have also been computed. It is found that, although drift-type microinstabilities persist over a wide range of values of the ion temperature gradient parameter $\eta_i \equiv (d \ln T_i/dr)/(d \ln n_i/dr)$, the characteristic features of the dominant mode are those of the η_i-type instability when $\eta_i > \eta_{ic} \sim 1.2$–$1.4$ and of the trapped-electron mode when $\eta_i < \eta_{ic}$.

29785 Electron cyclotron resonance heating in tandem-mirror end cells. Rognlien, T.D. (Lawrence Livermore National Laboratory, University of California, Livermore, California 94550 (USA)); Matsuda, Y.; Stallard, B.W.; Stewart, J.J. *Physics of Fluids B (USA),* 2(2): 338-352 (Feb 1990). DOE Contract W-7405-ENG-48.

A relativistic Fokker–Planck code is used to study the formation of non-Maxwellian electron velocity distributions in the end cell of a tandem mirror from the combined effects of Coulomb collisions and electron cyclotron radio-frequency (rf) heating. Axial electrostatic potential profiles consistent with thermal-barrier operation are assumed which lead to reasonable electron density profiles. The presence of the potentials results in four populations of electrons occupying different regions of phase space, three of which are solved for self-consistently; the fourth is the passing electron distribution from the center cell that is fixed as a Maxwellian. It is found that the second-harmonic barrier rf near the bottom of the magnetic well, together with rf cavity fields, give a good correspondence to the behavior of the hot electrons in the TMX-U experiment [IEEE Trans. Plasma Sci. **PS-16**, 1 (1988)]. The behavior of the fundamental rf in the plug region part way up the magnetic well shows poor correlation with experimental results.

29786 Resistive evolution of magnetic fields in plasmas. Miller, G. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545 (US)); Faber, V.; White, A.B. Jr. *Journal of Computational Physics (USA),* 85(2): 323-341 (Dec 1989).

In resistive evolution a quasistatic plasma is assumed to be in mechanical equilibrium at every instant of time. Equilibria are determined, in part, by magnetic flux constraints. The evolution of these flux constraints depends only on the electric field parallel to the magnetic field, as given by Ohm's law. The use of a new, magnetic-vector-potential formalism for the resistive evolution problem is discussed. This formalism has advantages of generality and simplicity as well as providing greater numerical accuracy in certain cases (such as the evolution of a magnetic island) where artificial singularities occur when using magnetic surface variables. Sample calculations of the evolution of a strongly driven (pinch) discharge with cylindrical symmetry and of the nonlinear growth of a helically symmetric m=2 magnetic island in the Rutherford regime are given. © 1989 Academic Press, Inc.

29787 A general concurrent algorithm for plasma particle-in-cell simulation codes. Liewer, P.C. (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California 91109 (USA)); Decyk, V.K. *Journal of Computational Physics (USA),* 85(2): 302-322 (Dec 1989). DOE Contract FG03-85ER25009;FG03-84ER53173.

We have developed a new algorithm for implementing plasma particle-in-cell (PIC) simulation codes on concurrent processors with distributed memory. This algorithm, named the general concurrent PIC algorithm (GCPIC), has been used to implement an electrostatic PIC code on the 33-node JPL Mark III Hypercube parallel computer. To decompose at PIC code using the GCPIC algorithm, the physical domain of the particle simulation is divided into subdomains, equal in number to the number of processors, such that

all sub-domains have roughly equal numbers of particles. For problems with non-uniform particle densities, these sub-domains will be of unequal physical size. Each processor is assigned a sub-domain and is responsible for updating the particles in its sub-domain. This algorithm has led to a a very efficient parallel implementation of a well-benchmarked 1-dimensional PIC code. The dominant portion of the code, updating the particle positions and velocities, is nearly 100% efficient when the number of particles is increased linearly with the number of hypercube processors used so that the number of particles per processor is constant. For example, the increase in time spent updating particles in going from a problem with 11,264 particles run on 1 processor to 360,448 particles on 32 processors was only 3% (parallel efficiency of 97%). Although implemented on a hypercube concurrent computer, this algorithm should also be efficient for PIC codes on other parallel architectures and for large PIC codes on sequential computers where part of the data must reside on external disks. © 1989 Academic Press, Inc.

29788 Poloidal rotation velocities in the outer half of Alcator-*C* plasmas. Benjamin, R.D. (Department of Physics and Astronomy—The Johns Hopkins University, Baltimore, Maryland 21218 (USA)); Terry, J.L.; Moos, H.W. *Physical Review, A (General Physics) (USA)*, 41(2): 1034-1040 (15 Jan 1990). DOE Contract AC02-76ET53006.

Poloidal rotation velocities in the outer half of ohmically heated Alcator-*C* plasmas have been determined from the Doppler shift of impurity emission lines. The measurements were made using a high-resolution photon-counting detector, sensitive to wavelengths from ~1200 to ~2000 Å, mounted in the exit plane of a 1-m Ebert-Fastie spectrometer. The following transitions were used: $2s2p^1P^0_1$–$2p^2\ ^1D_2$ at 1371.292 Å in O V, $2s\ ^2S_{1/2}$–$2p^2P^0_{1/2}$ at 1242.804 Å in N V (both of which exist near the limiter radius in Alcator-*C*), and $1s2s\ ^3S_1$–$1s2p\ ^3P^o_2$ at 1623.63 Å in O VII (which exists at r/a~0.8). The measured rotation velocities are $4–5\times10^5$ cm/s in the direction of the electron diamagnetic drift at the radius of the O V emission shell and $\sim6\times10^5$ cm/s at the radius of the O VII emission shell, again in the electron diamagnetic drift direction. Therefore poloidal rotation of the outer half of the Alcator-*C* plasma with a velocity of several times 10^5 cm/s in the direction of the electron diamagnetic drift is firmly established by these measurements.

29789 Effects of autoionizing resonances on density-sensitive spectral-line intensity ratios in high-temperature plasmas. Jacobs, V.L. (Condensed Matter and Radiation Sciences Division, Code 4694—Naval Research Laboratory, Washington, D.C. 20375-5000 (USA)); Hagelstein, P.L.; Chen, M.H.; Minner, R. *Physical Review, A (General Physics) (USA)*, 41(2): 1041-1057 (15 Jan 1990).

We present the results of detailed calculations for the intensity ratios between magnetic-quadrupole and electric dipole radiations that are emitted in the $3p^5$3d→$3p^6$ transitions from highly ionized argonlike ions with nuclear charges in the range $26\leq Z\leq70$. In arriving at our theoretical predictions, the population densities of the radiating $3p^5$3d singly excited fine-structure levels were determined by the application of a collisional-radiative equilibrium model, in which we have systematically and self-consistently incorporated the results of fully relativistic multiconfiguration calculations for the atomic energy-level structure and for the elementary atomic collision and radiation rates. In the determination of the population densities of the $3p^5$3d singly excited fine-structure levels, we have investigated the role of indirect processes involving the $3p^54l4l'$ intermediate autoionizing resonances and the $3p^43d^2$ doubly excited bound states.

29790 Equation of state of the one-component plasma derived from precision Monte Carlo calculations. Stringfellow, G.S. (Lick Observatory, Board of Studies in Astronomy and Astrophysics—University of California, Santa Cruz, California 95064 (USA)— Institute of Geophysics and Planetary Physics—Lawrence Livermore National Laboratory, Livermore, California 9 *Physical Review, A (General Physics) (USA)*, 41(2): 1105-1111 (15 Jan 1990). DOE Contract W-7405-ENG-48.

Analytical fits to the one-component plasma (OCP) equation of state have been derived for internal energies that have reduced all *N*-dependent effects to within the statistical uncertainties introduced by the Monte Carlo computational process, which themselves are very small. Values of $N\gtrsim500$ adequately represent the thermodynamic limit. Using the fluid internal energies for only N=686, various analytical fits are generated, compared, and discussed. The thermal energy is accurately represented by a simple power-series fit with the leading term given by $\Gamma^{1/3}$, but also requires a small correction to the bcc Madelung term that brings that coefficient down to nearly −0.9, the value derived for hypernetted-chain theory. The fluid thermal energy data are reproduced to better than 0.2% over all Γ by our fit(s). The solid phase requires *both* anharmonic terms to be included in the fit, implying that the previous justification for dropping the first anharmonic correction is unwarranted. The location of the fluid-solid phase transition utilizing these new fits yields Γ_{bcc}=178 and Γ_{fcc}=192.

29791 Irradiation of LWIR detectors with x-rays generated near the sample. Flesner, L.D. (Naval Ocean Systems Center, San Diego, CA (US)); O'Brien, M.E.; Rogers, C.G.; Moore, T.G. *IEEE Transactions on Nuclear Science (Institute of Electrical and Electronics Engineers) (USA)*, 36(6): 1920-1925 (Dec 1989). (CONF-890723–: 26. annual conference on nuclear and space radiation effects, Marco Island, FL (USA), 25-29 Jul 1989).

An approach for testing the effects of ionizing radiation on long-wavelength infrared (LWIR) detectors operating in a thermally-shielded environment is described. An electron beam is introduced into a cryogenic chamber and used to generate low-energy X-rays in a cold target foil proximate to the detector. Applications of the method include ionization induced noise and accumulated dose studies.

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Refer also to citation(s) 27789, 27790, 28397, 28565, 28781, 28880, 28881, 28937, 29521, 29624, 29625, 29665, 29673, 29691, 29692, 29693, 29733, 29734, 29736, 29738, 29739, 29740, 29741, 29750, 29766, 29767, 29768, 29769, 29773, 29774, 29775, 29791

29792 (CONF-891007–Vol.1) **IEEE thirteenth symposium on fusion engineering: Proceedings: Volume 1.** Lubell, M.S.; Nestor, M.B.; Vaughan, S.F. (eds.). Oak Ridge National Lab., TN (USA). c [1989]. 782p. Sponsored by American Institute of Aeronautics and Astronautics; American Nuclear Society; U.S. DOE Energy Research; Institute of Electrical and Electronics Engineers. DOE Contract AC05-84OR21400. From 13. IEEE symposium on fusion engineering; Knoxville, TN (USA); 2-6 Oct 1989. Available from IEEE Service Center, Single Publications Sales Dept., 445 Hoes Lane, Piscataway, NJ 08855-1331.

This report contains papers of the following topics on fusion engineering: magnet engineering; blanket engineering; electric power control; plasma engineering; vacuum systems and vessels; diagnostic systems; controls, instrumentation, and data acquisition; heating and current drive; next generation devices; health and safety; magnet materials and insulation; quality assurance and reliability; electrical generators; divertors and plasma-facing components; power systems; tritium; and inertial confinement fusion. These papers have been procedure and cataloged separately. (LSP)

29793 (CONF-891007–Vol.2) **IEEE thirteenth symposium on fusion engineering: Proceedings: Volume 2.** Lubell, M.S.; Nestor, M.B.; Vaughan, S.F. (eds.). Oak Ridge National Lab., TN (USA). c [1989]. 785p. Sponsored by American Institute of Aeronautics and Astronautics; American Nuclear Society; U.S. DOE Energy Research; Institute of Electrical and Electronics Engineers. DOE Contract AC05-84OR21400. From 13. IEEE symposium on fusion engineering; Knoxville, TN (USA); 2-6 Oct 1989. Available from IEEE Service Center, Single Publications Sales Department, 445 Hoes Lane, Piscataway, NJ 08855-1331.

This report contains papers of the following topics on fusion engineering: magnetic engineering; blanket engineering; plasma engineering; vacuum systems and vessels; controls, instrumentation, and data acquisition; heating and current drive; health and safety; magnet materials and insulation; quality assurance and reliability; electrical generators; divertors and plasma-facing components; power systems; tritium; inertial confinement fusion; plasma

fueling; cryogenics; commercial reactors; shielding; and design and performance. (LSP)

29794 (CONF-900602–2) **Cleanup and improvement of operational performance of ATF [Advanced Toroidal Facility] by chromium and titanium gettering.** Isler, R.C.; Bigelow, T.S.; Crume, E.C.; England, A.C.; Glowienka, J.C.; Horton, L.D.; Jernigan, T.C.; Langley, R.A.; Lyon, J.F.; Mioduszewski, P.K. Oak Ridge National Lab., TN (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 17. European conference on controlled fusion and plasma heating; Amsterdam (Netherlands); 25-29 Jun 1990. Order Number DE90009827. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Several improvements have been realized recently in the performance of the Advanced Toroidal Facility (ATF). These have been achieved largely because of expanded employment of chromium and titanium gettering, as opposed to the earliest wall conditioning efforts that relied solely on glow discharge cleaning and baking. Spectroscopic analysis indicates that radiation decreases from as much as 75% to about 25% of the input power between nongettered operation and operation when approximately 70% of the vacuum vessel walls are covered with titanium. Nevertheless, the most important contribution of gettering appears to be the reduction of recycling and of hydrogen evolved from the walls during a discharge, thereby permitting better control of the gas fueling rate. As a result, operational procedures have been developed that allow much higher densities to be obtained than those reached without gettering. The maximum stored energy, confinement time, and line averaged density obtained in ATF to date are: 28 kJ, 25 ms, and 1.2×10^{14} cm^{-3}. In addition, quasisteady operation during neutral beam injection (NBI) into high-density plasmas has been achieved without the evolution to collapse which characterizes the low-density discharges. This paper describes the changes of impurity radiation effected by gettering and compares the behavior of low-density and high-density plasmas when titanium films are deposited over 50% or more of the vacuum vessel walls. 2 refs., 2 figs., 1 tab.

29795 (CONF-900602–4) **Development of fast-wave ICRF [ion cyclotron range of frequencies] current drive systems at ORNL.** Goulding, R.H.; Baity, F.W.; Batchelor, D.B.; Hoffman, D.J.; Jaeger, E.F.; Mayberry, M.J.; Ryan, P.M. Oak Ridge National Lab., TN (USA). [1990]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 17. European conference on controlled fusion and plasma heating; Amsterdam (Netherlands); 25-29 Jun 1990. Order Number DE90009818. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A series of proof-of-principle fast-wave current drive (FWCD) experiments in the ion cyclotron range of frequencies (ICRF) will begin soon on the DIII-D tokamak at General Atomics. These experiments will use a four-strap, 2-MW phased antenna array designed and built at Oak Ridge National Laboratory (ORNL). The antenna array will operate at a frequency of 60 MHz and is expected to drive currents at 0.25 to 0.5 MA in moderate-density ($\bar{n}_e \sim 1.3 \times 10^{19}$ m^{-3}) plasmas with $T_{e0} \sim 4$ keV and a toroidal field $B = 1$ T. We discuss development work undertaken at ORNL to predict the performance of the phased array and its feed circuit and to assist in the design of future FWCD systems. 6 refs., 5 figs.

29796 (CONF-900623–3) **Vanadium alloys with improved resistance to helium embrittlement.** Braski, D.N. Oak Ridge National Lab., TN (USA). [1990]. 34p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 15. symposium on effects of radiation on materials; Nashville, TN (USA); 17-21 Jun 1990. Order Number DE90009811. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A series of experimental vanadium alloys have been designed with small MC-type carbides in their microstructures to trap helium produced during neutron irradiation, thereby reducing helium embrittlement. The tensile properties and fabricability of the alloys were strongly influenced by the amounts of MC-forming-elements, especially carbon. Alloys with 0.05 and 0.10 wt % carbon exhibited slightly lower yield strengths at 420 to 600°C than vanadium alloys such as V-5Cr-5Ti, Vanstar-7, V-3Ti-1Si, and V-15Cr-5Ti. However, this characteristic may actually be an asset from the standpoint of resistance to irradiation hardening. After implantation with 300 appm ^3He, both the V-Ti-C and V-Ti-Zr-C alloys exhibited less ductility losses at 600°C than the other vanadium alloys tested under comparable conditions. Examination of the experimental alloy microstructures by AEM showed that the small MC-type carbides did, in fact, trap helium and that they were responsible for the increased resistance to helium embrittlement of these alloys. 16 refs., 12 figs., 2 tabs.

29797 (CONF-9003116–1) **Pellet injection into ATF plasmas.** Wilgen, J.B. (Oak Ridge National Lab., TN (USA)); Bell, J.D.; England, A.C.; Fisher, P.W.; Howe, H.C.; Murakami, M.; Rasmussen, D.A.; Richards, R.K.; Uckan, T.; Wing, W.R. Oak Ridge National Lab., TN (USA). [1990]. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. (CONF-9003117–1: US-USSR exchange visit to Kharkov Physico-Technical Institute seminar; Experiments on the Wendelstein VII-AS and ATF stellerators seminar; US-USSR exchange visit to Institute of General Physics seminar, Kharkov (USSR); Munich (Germany, F Order Number DE90009229. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Based on the favorable empirical scaling of stellarator confinement with increasing electron density, pellet fueling is expected to result in significant performance improvement of the ATF plasma. With gas-puff fueling, NBI heated plasmas in ATF are limited by a thermal collapse. Pellet fueling provides a potential means to delay this effect and gain access to the favorable high density confinement regime. To provide flexibility for optimization and physics studies, eight different pellet sizes are available. To date, line average densities of up to 4×10^{13} cm^{-3} have been achieved with a single pellet injected into a 0.7 MW NBI plasma at 0.95 T; the results from optimization studies with up to 1.5 MW of NBI power at 2 T will be presented.

29798 (CONF-9006162–2) **Test methods for evaluating hot cracking: Review and perspective.** Goodwin, G.M. Oak Ridge National Lab., TN (USA). [1990]. 26p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. (CONF-9006149–2: 1. U.S.-Japan symposium on advances in welding metallurgy; 1. United States - Japan symposium on advances in welding metallurgy, Yokohama (Japan); San Francisco, CA (USA), 12-13 Jun 1990; 7-8 jun 1990). Order Number DE90009820. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The phenomenon of hot cracking is described and discussed, and criteria for tests to assess hot cracking are elucidated. The historical development of hot cracking tests is traced from the 1930s to present, with categorization of tests into several types. It is noted that the number of tests developed continues to increase dramatically. The number of literature citations also increases with time, with few popular tests receiving a major share of interest. Predominant countries of origin of both tests and citations shift with time, and a few journals account for most of the published information. Reviews of hot cracking are reviewed, and it is predicted that modeling and other developing analytical techniques will contribute greatly to an increase in our understanding of hot cracking. 30 refs., 10 figs., 1 tab.

29799 (DOE/ER/52161–1) **Corrosion studies of a stainless steel structure for the ITER [International Thermonuclear Experimental Reactor] aqueous lithium salt blanket concept: Technical progress report.** Duquette, D.J.; Wrisley, K.L.; Motyka, E.; Steiner, D.; Embrechts, M.J. Rensselaer Polytechnic Inst., Troy, NY (USA). Mar 1990. 28p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-89ER52161. Order Number DE90009925. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The aqueous lithium salt blanket (ALSB) employs water, with a dissolved lithium compound, as both the coolant and tritium breeding medium. The ALSB concept is one of three blanket options currently being examined for breeding tritium in the International Thermonuclear Experimental Reactor (ITER). To provide data and recommendations for materials and chemistry selection relevant to application of the ALSB in ITER, corrosion studies have been initiated, focusing on Type 316 stainless steel in lithium hydroxide and lithium nitrate solutions. This report presents the preliminary results of these corrosion studies. 4 refs., 9 figs., 1 tab.

29800 (IPP–III/139, pp. 34-39) **ASDEX edge and divertor simulation and the problem of incomplete and inaccurate experimental data.** Schneider, W.; Neuhauser, J.; Haas, G.; McCormick, K.; Tsois, N.; Wunderlich, R. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1988. In *ASDEX contributions to the 8th international conference on plasma surface interaction in controlled fusion devices, Juelich, May 2-6, 1988 and international workshop on plasma edge theory, Augustusburg (GDR), April 26-30, 1988.* Order Number DE90780658. Available from NTIS (US Sales Only), PC A07/MF A01.

The one-dimensional hydrodynamic code SOLID coupled with the two-dimensional Monte Carlo neutral gas code DEGAS are used to simulate the scrape-off layer and divertor recycling region of the ASDEX tokamak. A numerical data base is created for the relevant parameter regime and compared to the limited amount of experimental data. A reasonable fit with ohmic data is obtained, assuming classical heat flow along field lines and allowing for varying divertor saturation. The problem of experimental errors on one side and deficiencies in the theoretical model on the other side are discussed. (orig.).

29801 (IPP–III/139, pp. 40-52) **Comparison of recycling in the ASDEX divertor before and after hardening.** Haas, G.; Poschenrieder, W.; Neuhauser, J.; Kaesdorf, S. ASDEX Team; NI Team. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Nov 1988. In *ASDEX contributions to the 8th international conference on plasma surface interaction in controlled fusion devices, Juelich, May 2-6, 1988 and international workshop on plasma edge theory, Augustusburg (GDR), April 26-30, 1988.* Order Number DE90780658. Available from NTIS (US Sales Only), PC A07/MF A01.

The original ASDEX-divertor was not capable to dissipate the heat load of long pulse NBI and ICRH. In a partial reconstruction termed hardening, new water-cooled divertor components were installed. The modified divertor geometry resulted in some significant changes, e.g. in gas consumption and divertor pressure. Difficulties in obtaining a good H-mode are possibly connected to the modified recycling behaviour. However, a new regime with improved ohmic confinement (IOC) and reduced recycling is now found. (orig.).

29802 (JAERI-M–89-193) **Analysis of ICRF heating and current drive in ITER.** Fukuyama, Atsushi (Okayama Univ. (Japan). School of Engineering); Hamamatsu, Kiyotaka; Itoh, Sanae-I; Itoh, Kimitaka. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 28p. (In Japanese). Order Number DE90777749. Available from NTIS (US Sales Only), PC A03/MF A01.

Feasible frequency range of ion cyclotron waves for heating and current drive in an ITER-grade tokamak are searched for and analyzed in detail. Key constraints of the choice are loading impedance, power partition to each plasma species (electron, deuteron, trition and α particles), radial deposition profiles and sensitivity to α particle population. Solving an integro-differential equation for the wave, we examine wave propagation and absorption in a wide range of frequency from less than ω_{cT} to more than $4\omega_{cT}$ (i.e., 10 MHz $\approx$ 100 MHz) for the plasma of D-T mixture. Looking for the frequency range insensitive to the absorption by α particles, we find that the frequency near $2\omega_{cT}$ (54 MHz) is suitable for current drive, though the drive efficiency is not so high. The frequency of ω_{cD} (39 MHz) and $2\omega_{cD} = 3\omega_{cT}$ (81 MHz) are also available for central heating. When $\omega < \omega_{cT}$, most of the power is absorbed by electrons; however, it its difficult to obtain stable antenna coupling owing to standing wave formation. (author).

29803 (JAERI-M–89-202) **Preliminary design of test facilities for tritium breeding blanket development, (1).** Japan Atomic Energy Research Inst., Tokyo (Japan). Dec 1989. 123p. (In Japanese). Order Number DE90777741. Available from NTIS (US Sales Only), PC A06/MF A01.

This report describes the results of the preliminary design of outpile test facilities which are used for development of tritium breeding blanket with ceramic breeding material. The facilities which were designed are as follows; High heat flux test facility, Thermal-hydraulic test facility, Integrity test facility, Fabrication Technology Development Facility. This design study was performed by Kawasaki Heavy Industries, Ltd. under the contract to Fusion Research System Laboratory. (author).

29804 (KFK–4677) **Nuclear fusion project. Semi-annual report of the Association KfK/Euratom. April 1989 - September 1989.** Kast, G. (comp.). Kernforschungszentrum Karlsruhe GmbH (Germany, F.R.). Nov 1989. 101p. (EUR–11397-EN). Order Number DE90780228. Available from NTIS (US Sales Only), PC A06/MF A01.

Report on the technology program for NET: Plasma facing components, magnets, tritium fuel cycle, basic blanket, remote handling and maintenance, safety and environment, solid breeder and liquid metal test blankets, mechanical properties of pre- and post-irradiation of 1.4914 steel (MANET), ECRH power sources, NET study contracts. (HP).

29805 (N–90-15836, pp. 56-67) **Introduction to D-He(3) fusion reactors.** Vlases, G.C.; Steinhauer, L.C. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Jul 1989. (NASA-TM–101652;NAS–1.15:101652). In *Report of NASA Lunar Energy Enterprise Case Study Task Force.* Available from NTIS, PC A09/MF A02.

A review and evaluation of D-He(3) fusion reactor technology is presented. The advantages and disadvantages of the D-He(3) and D-T reactor cycles are outlined and compared. In addition, the general design features of D-He(3) tokamaks and field reversed configuration (FRC) reactors are described and the relative merits of each are compared. It is concluded that both tokamaks and FRC's offer certain advantages, and that the ultimate decision as to which to persue for terrestrial power generation will depend heavily on how the physics performance of each of them develops over the next few years. It is clear that the D-He(3) fuel cycle offers marked advantages over the D-T cycle. Although the physics requirements for D-He(3) are more demanding, the overwhelming advantages resulting from the two order of magnitude reduction of neutron flux are expected to lead to a shorter time to commercialization than for the D-T cycle.

29806 (PPLK-R–39) **Summary of IAEA technical committee meeting on impurity control.** Itoh, Kimitaka. Kyoto Univ., Uji (Japan). Plasma Physics Lab. Mar 1989. 43p. Order Number DE90777731. Available from NTIS (US Sales Only), PC A03/MF A01.

Presentations given in the IAEA technical committee meeting on impurity control (held in JAERI from 13 to 15 February, 1989) are summarized, putting the emphasis on the physics modelling of the plasma related to the impurity production and confinement. (author).

29807 (PPLK-R–42) **Recent activity on Heliotron E physics study and engineering developments.** Obiki, T. (and others); Wakatani, M.; Sato, M. Kyoto Univ., Uji (Japan). Plasma Physics Lab. Jun 1989. 70p. Order Number DE90777728. Available from NTIS (US Sales Only), PC A04/MF A01.

Recent activity on Heliotron E physics study about transport, MHD stability, and divertor action with new equipments is summarized. For the above purpose, appropriate pellet injector and new diagnostics are developed. Moreover, research and developments about heating systems and the other new systems for the Large Helical Device are being carried out by the Heliotron group. (author).

29808 (PPLK-R–45) **Magnetic field near plasma boundary in toroidal helical systems.** Nagasaki, Kazunobu; Itoh, Kimitaka. Kyoto Univ., Uji (Japan). Plasma Physics Lab. Jul 1989. 38p. Order Number DE90777727. Available from NTIS (US Sales Only), PC A03/MF A01.

Magnetic field structure of the scrape off layer (SOL) region in toroidal helical systems is analyzed by using toroidal harmonic functions. The SOL region in toroidal helical systems is ergodic due to the toroidal effect. The connection length of the field line to the wall is calculated for various configurations. The connection length, L, has a logarithmic dependence on the distance from the outermost magnetic surface or from the residual magnetic islands, δ. The effect of axisymmetric fields on the field structure is also determined. The coefficient, $L/\ln\delta$, is weakly dependent on the toroidal field and is nearly independent of the vertical field. (author).

29809 (RTS-R–016) **The use of lithium oxide as the breeder in fusion reactors.** Dodd, J.A. (UKAEA Risley Technical Services, Risley (UK)); Baker, L.J.; Kennedy, P.; Challender, R.S.; Coast, G. UKAEA Risley Technical Services, Risley (UK). Jul 1989. 85p. Order Number DE90623638. Available from NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS.

Lithium oxide as a fusion blanket material has neutronic advantages but various design limitations. The study was undertaken to investigate the design implications, to demonstrate how the limitations can be overcome and to provide guidance for future development. The study included lithium oxide properties, tritium control, coolant chemistry, blanket engineering and blanket neutronics. (author).

29810 (SAND–89-1088) **Magnetic Fusion Energy Program: Annual report 1988.** Doyle, B.L. (Sandia National Labs., Albuquerque, NM (USA)); Whitley, J.B.; Wilson, K.L.; Garber, R.A. Sandia National Labs., Albuquerque, NM (USA). 1988. 104p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE90009521. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

This report discusses the projects and device support for the following thermonuclear reactors: Tokamak Fusion Test Reactor, Compact Ignition Tokamak, International Thermonuclear Experimental Reactor, Joint European Torus, Textor, Tore-Supra, DIII-D, and ASDEX and ASDEX Upgrade. This paper also discusses High-Heat Flux Materials and Components and Plasma Surface Interactions Research.

29811 (UCRL–21203-Vol.2) **Theoretical studies and algorithm development for x-ray lasers: Volume 2: April–November 1989.** Hagelstein, P.L.; Kaushik, S.; Balents, L. Lawrence Livermore National Lab., CA (USA). Nov 1989. 88p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010120. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report describes the results of research on x-ray lasers performed for the Lawrence Livermore National Laboratory under LLNL subcontract BO48704 during the period April 1989 through November 1989. Additional effort through the report date is included in this document. We have been moderately successful in our efforts during the past year. Substantial improvements in the conjugate gradient algorithms have been made, both in efficiency and in robustness. We have obtained a key technical result in our DHF and self-energy studies, which may allow us to obtain a rigorous derivation of our heuristic formulas. We report progress in the modeling and design of the GaAs quantum well x-ray detector.

29812 (UCRL–50021-87) **Laser Program annual report 1987.** O'Neal, E.M.; Murphy, P.W.; Canada, J.A.; Kirvel, R.D.; Peck, T.; Price, M.E.; Prono, J.K.; Reid, S.G.; Wallerstein, L.; Wright, T.W. (eds.). Lawrence Livermore National Lab., CA (USA). Jul 1989. 669p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90008198. Available from NTIS, PC A99/MF A01 - OSTI; GPO Dep.

This report discusses the following topics: target design and experiments; target materials development; laboratory x-ray lasers; laser science and technology; high-average-power solid state lasers; and ICF applications studies.

29813 (UCRL-CR–103211) **Producing dense plasmas with x-rays.** Matthews, D. (Lawrence Livermore National Lab., CA (USA)); Trebes, J.C.; Falcone, R.; Da Silva, L.B. Lawrence Livermore National Lab., CA (USA). Mar 1990. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90009539. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Plasmas generated by x-ray irradiation rather than optical lasers achieve density and temperatures of interest to astrophysics, inertial confinement fusion and atomic physics. In the past year we have developed and characterized a facility capable of focusing broadband x-rays from a laser produced plasma to flux levels of $\approx 10^4$ J/cm^2. 2 figs.

29814 (WHC-SA–0693) **The design and performance of high-temperature irradiation capsules.** Greenslade, D.L.; Knight, R.C.; Ermi, A.M. Westinghouse Hanford Co., Richland, WA (USA). Mar 1990. 21p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. (CONF-900623–1: 15. symposium on effects of radiation on materials, Nashville, TN (USA), 17-21 Jun 1990). Order Number DE90007822. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Characterization of high-temperature materials behavior in a neutron environment will be required to develop reliable performance prediction models for high-temperature gas-cooled, space power, and fusion reactors. One vehicle by which material behavior in a fast neutron environment can be studied is the Materials Open Test Assembly (MOTA) in the Fast Flux Facility (FFTF). Until recently, irradiation temperatures in the MOTA were limited to 1075 K. A recent successful experiment, however, has extended the temperature capability in the MOTA to 1500 K. This report describes the design and performance of high-temperature capsules that were used in that experiment. Each of eight uniquely designed instrumented capsules (which contained refractory metal specimens) operated at an irradiation temperature between 1290 and 1500 K. Temperatures within +/−10 K of target were maintained in seven of the eight capsules during the 335-day irradiation. Data obtained during the experiment clearly showed the advantages of having a temperature control system for high-temperature irradiation capsules. 7 refs., 6 figs., 1 tab.

29815 PC application in DIII-D neutral beam operation. Gladd, A.S. (GA Technologies, Inc., Oak Ridge, TN (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

An IBM PC/AT has been implemented to improve operation of the DIII-D neutral beams. The PC system provides centralization of all beam data with reasonable access for online shot-to-shot control and analysis. The PC hardware was configured to interface all four neutral beam host mini-computers, support multi-tasking, and provide storage for approximately one month's accumulation of beam data. The PC software is composed of commercial packages used for performance and statistical analysis (i.e. LOTUS 123, PC PLOT, etc.) host communications software (i.e. PCLINK, KERMIT, etc.) and applications developed software utilizing FORTRAN and BASIC. The objectives of this paper are to describe the implementation of the PC system, the methods of integrating the various software packages, and the scenario for online control and analysis.

29816 Fiber-optic control of the ZT-P experiment. Caudill, L.D. (Los Alamos National Lab., NM (USA)); Chandler, G.I.; Hall, C.R.; Trujillo, J.F. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The computer control system for the ZT-P experiment has been implemented using a fiber-optic link in all 161 control signal paths. Four classes of control signals are used in this design. These are: digital-out; an on-off signal from computer to machine actuator, digital-in, and on-off signal from machine sensor to computer, analog-out, a 0 - 10 volt analog signal from computer to machine actuator, analog-in, 0 to +1 milliampere analog signal from machine sensor to computer. The digital-in and the digital-out class of signals require no control power at the machine end. The analog-out and the analog-in class of signals use available machine power for control. This unique power arrangement and the use of fiber-optic links serve to totally isolate electrically noisy machine areas from the sensitive electronics in the computer control. Advantages, including low cost, small size, personnel safety, and ease of maintenance and modification are discussed.

29817 A general distributed control system for fusion experiments. Klingner, P.L. (Los Alamos National Lab., NM (USA)); Levings, S.J.; Wilkens, R.W. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton

Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report the development of a general control system using distributed LSI-11 microprocessors. Common software resides in each LSI-11 and is tailored to an application by control specifications downloaded from a host computer. The microprocessors, their control interfaces, and the micro-to-host communications are CAMAC based. The host computer also supports an operator interface, coordination of multiple microprocessors, and utilities to create and maintain the control specifications. Typical applications include monitoring safety interlocks as well as controlling vacuum systems, high voltage charging systems, and diagnostics.

29818 **MDS/MIT data system.** Fredian, T.W. (Massachusetts Inst. of Tech., Cambridge, MA (USA)); Stillerman, J.A. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

MDS is a high speed VAX based CAMAC oriented data acquisition and analysis system. It was developed for use on the ALCATOR-C and TARA experiments. MDS consists of a coherent set of general purpose, flexible tools for experimental data handling. Using MDS a scientist can set up a complete diagnostic including CAMAC data acquisition, display, and analysis without writing any code. The computer equipment on which MDS is installed ranges from large VAXclusters to small stand-alone MicroVAX II systems. The authors present an overview of the MDS system. They discuss planned improvements in the system, and discuss ideas for future enhancements that may benefit MDS sites.

29819 **The computer control and data acquisition system for the R. R. test facility.** Stewart, K.A. (ORNL (US)); Burris, R.D.; Mankin, J.B.; Thompson, D.H. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The radio frequency test facility (RFTF) at Oak Ridge National Laboratory, used to test and evaluate high power ion cyclotron resonance heating (ICRH) systems and components, is monitored and controlled by a multi-component computer system. The programmable controller (PLC) performs all the control functions of the test facility. The VAX computer acts as the operator's interface to the test facility by providing color mimic panel displays and allowing input via a trackball device. The VAX also provides archiving of trend data acquired by the PLC. Communications trend data acquired by the PLC. Communications between the PLC and the VAX are via the CAMAC serial highway. Details of the hardware, software, and the operation of the system are presented.

29820 **Design and implementation of a control system for deuterium pellet injector.** Burris, R.D. (ORNL (US)); Baylor, L.R.; Greenwood, D.E.; Stewart, K.A. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The Oak Ridge National Laboratory is currently developing a deuterium pellet injector for installation on the Tokamak Fusion Test Reactor (TFTR). This paper describes the design and development of a stand-alone data acquisition and control system for that device. Major elements of the hardware are described. The PLC performs all actual control actions and acquires data pertinent to those actions. The MicroVAX receives the data acquired by the PLC, displays it for the operator, prompts for and processes requests for action from the operator, and informs the PLCV of those requests. The primary purpose of this paper is to describe the software operating in the MicroVAX, including the system architecture, major tasks, and ancillary and background tasks.

29821 **The block transfer system: From conception through the first year of operation.** Bradish, G.J., III; Reid, A.E. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The central instrumentation control and data acquisition (CICADA) computer system is comprised of a functionally distributed hierarchical network of thirteen (13) 32-bit mini-computers that are the heart of the control, monitoring, data collection and data analysis for the tokamak fusion test reactor (TFTR). The CICADA system was designed with the goal of providing complete control, monitoring, and data acquisition for TFTR, which includes the acquisition and storage of 20M points of data within a five-minute shot cycle. It was realized early in the system design that in order to meet this goal an ancillary system would have to be provided to supplement the subsystem CAMAC systems that, due to the relatively slow throughput of the serial highways and the overhead of relaying data to the central facilities within a star network, would not provide the necessary throughput. The authors discuss how the block transfer system provided a means of moving data directly from the CAMAC crate to the application running on the central facility computers.

29822 **TFTR status and alarm system.** Drucker, L. (Princeton Univ., NJ (USA)); Fleming, G.; Sauthof, N.; Stark, W. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The authors report on the status and alarm system being implemented for TFTR to allow machine operators to be notified when conventional monitored values go into an alarm state. The system will allow the display of maintained points and alarms on any configured graphic output device. The displays may include calculated software points which represent the result of expressions involving the states of other points or groups of points. The calculated points are treated in a fashion identical to conventional points, allowing the utilization of existing program generation and access routines. The system permits operator notification of any change in the alarm states of a point or group of points on any selection of pages. In addition, the user can modify the alarm limits or the normal states of points on a page, by a command within that page.

29823 **Software development for TFTR.** Christianson, G. (Princeton Univ., NJ (USA)); Davis, W.; Diesso, M.; Lagin, L.; Malsury, J.; Matone, J.; Schectman, N.; Snyder, J.; Terpstra, T. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The development of software for the TFTR machine is discussed. Key problems in the development process are control of a large body of applications code and the provision of an environment that maximizes the productivity of the applications programmers. Control of the large body of code is accomplished through the use of a common method of software module specification, standard naming conventions, standard documentation, and automated utility programs to check the consistency of source code. The productivity of the applications programmers is enhanced by the presence of services providing graphics capabilities, terminal and user dialog management, data access, smoothing and compression, hardware device access and testing, and program execution tracing.

29824 **TFTR computer system graphics support.** Stark, W. (Princeton Univ., NJ (USA)); Chu, J. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Developments in the tokamak fusion test reactor (TFTR) computer graphics system in support of physics operations and diagnostic data reduction are described. There are approximately 170 graphics devices connected to the TFTR computer system via a serial CAMAC highway. The graphics support system permits these devices to be accessed via shared memory from any task

within the computer system configuration. The increase in the number of user station, as well as the sophistication of data reduction, has driven an increase in the requirement for graphics speed. The introduction of parallelism, multiple buffering, and no-wait processing has enabled rates of 800,000 points/minute to be supported. A shadowing feature has been added which allows the most recent plot for each screen to be stored on disk, and subsequently available to a spooling system which supports transmission of plot files to laser plotters and other devices based on interactive command.

29825 TFTR data management system. Randerson, L. (Princeton Univ., NJ (USA)); Chu, J.; Ludescher, C.; Malsbury, J.; Stark, W. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Developments in the tokamak fusion test reactor (TFTR) data management system supporting data management system supporting data acquisition and off-line physics data reduction are described. Data from monitor points, timing channels, and transient recorder channels and other devices are acquired and stored for use by on-line tasks. Files are transferred off-line automatically. A configuration utility determines data acquired and files transferred. An event system driven by file arrival activates off-line reduction processes. A post-run process transfers files not shipped during runs. Files are archived to tape and are retrievable by digraph and shot number. Automatic skimming based on most recent access, file type, shot numbers, and user-set protection maintains the files required for post-run data reduction.

29826 Software architecture for the ORNL large coil test facility data system. Blair, E.T. (ORNL (US)); Baylor, L.R. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The VAX based data acquisition system for the international fusion superconducting magnetic test facility (IFSMTF) at Oak Ridge National Laboratory (ORNL) is a second generation system that evolved from a PDP-11/60 based system used during the initial phase of facility testing. The VAX based software represents a layered implementation that provides integrated access to all of the data sources within the system, decoupling en-user data retrieval from various front-end data sources through a combination of software architecture and instrumentation data bases. Independent VAX processes manage the various front-end data sources, each being responsible for controlling, monitoring, acquiring, and disposing data and control parameters for access from the data retrieval software.

29827 The TMX~U computer system in evolution. Casper, T.A. (Lawrence Livermore National Lab., CA (USA)); Bell, H.; Brown, M.; Gorvad, M.; Meyer, W.; Mollen, J.; Perkins, D. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

This paper reports how the TMX~U diagnostic data base has grown to 9 Mbytes with over 1300 channels; roughly triple the originally designed size. This acquisition and processing limits the repetition rate to about 10 min per shot using the five original HP-1000 computers with shared disks. The new diagnostics tend to be multichannel instruments, which can be more easily managed using local computers. HP-series 200 and 500 computers are being used for instrument control, data acquisition, and analysis. Eight such systems are operational with processed format output exchanged via a shared resource manager. The authors are presently implementing the necessary hardware and software changes to create a local area network allowing us to combine the data from these systems with our main data archive. The expansion of their diagnostic system using the parallel acquisition and processing concept allows them to increase their data base with a minimum impact on the experimental repetition rate.

29828 Software systems for processing and analysis of experimental data at the Nova laser facility. Auerbach, J.M. (Lawrence Livermore National Lab., CA (USA)); McCauley, E.W.; Stone, G.F.; Montgomery, D.S. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

A typical laser-plasma interaction experiment at the Nova laser facility produces in excess of 20 megabytes of digitized data. Extensive processing and analysis of this raw data from a wide variety of instruments is necessary to produce data that can be readily used to interpret the experiment. The authors describe how using VAX based computer hardware, a software system has been set up to convert the digitized instrument output to physics quantities describing the experiment. A relational data base management system is used to coordinate all levels of processing and analysis. Extensive data bases of instrument response and set-up parameters are used at all levels of processing and archiving. An extensive set of programs is used to handle the large amounts of X, Y, Z data recorded on film by the bulk of Nova diagnostics. Software development emphasizes structured design, flexibility, automation and ease of use.

29829 Summary of control and data acquisition systems for Nova based inertial confinement studies. McCauley, E.W. (Lawrence Livermore National Lab., CA (USA)); Auerbacl, J.M.; Montgomery, D.S.; Randolph, J.E.; Shaw, J. G.; Stone, G.F. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

The Nova Laser has completed its first year of operation. During this period, emphasis has been placed on activation of the facility and of the numerous target and beam diagnostics. Two separate target chambers are in use. Nova operation is separated into two broad functions: laser operations and experiments. The operations group provides the laser system control, operation and data acquisition and the experiments group provides experiment definition, diagnostic instrumentation and overall data processing. This paper reports on the overall Operations side. VAX 11/780 computers are used to set up diagnostic operating parameters and collect data recorded by the CAMAC and CCD modules. These data are delivered in files by electronic link to the laser experiments and analysis facility (LEAF) VAX 11/785 of the experiments group for processing. Film data are digitized at LEAF and the film data files also processed on the LEAF VAX.

29830 Parametric study of electron density profile evolution following pellet injection in TFTR. Park, H.K. (Princeton Univ., NJ (USA)); Mansfield, D.K.; Johnson, L.C. pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Recent results from TFTR pellet experiments have extended previous results to a larger volume and longer time scales. In this paper, the detailed study of electron density profile response following pellet injection is discussed. In particular, hollow density profiles with relatively long relaxation time (10 $\sim$ 100 msec) from inverted gradient are obtained by injection of 2.67 mm diameter pellets, which penetrate to r $\simeq$ a/2. Strongly peaked profiles and central electron density - 2 x $10^{20}m^3$ are obtained by injection of a 4 mm diameter pellet, which penetrates to or beyond the magnetic axis. In both cases, the pellet mass is well accounted for by the measured density perturbation.

29831 Diagnostic control, data acquisition, and data processing at MFTF-B. Preckshot, G.G. (Lawrence Livermore National Lab., CA (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). DOE Contract W-7405-ENG-48. (CONF-860324–: 6. topical conference

on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Diagnostic instruments at the Mirror Fusion Test Facility (MFTF-B) are operated by a distributed computer system which provides an integrated control, data acquisition, and data processing interface to the experimentalast. Instrument control settings, operator inputs and lists of data to be acquired are combined with data acquired by instrument data recorders, to be used downstream by data processing codes; data processing programs are automatically informed of operator control and setpoint actions without operator intervention. The MFTF-B distributed computing environment permits the authors to take advantage of several kinds of computing equipment and commercial software. The combined diagnostic control and results presentation interface is presented to experimentalast users by a network of high-resolution graphics workstations. Control coordination, data processing, and database management are handled by a shared-memory network of 32-bit super minicomputers. Direct instrument control, data acquisition, data packaging, and instrument status monitoring are performed by a network of dedicated local control microcomputers. A description of this system and the authors' experiences in implementing the first MFTF-B diagnostic instrument, the magnetic field alignment (MFA) diagnostic, are reported.

29832 TFTR CAMAC data acquisition system. Rauch, W.A. (Princeton Univ., NJ (USA). Plasma Physics Lab. (USA)). pp. 92 of Proceedings of the 6th topical conference on high temperature plasma diagnostics. Princeton Plasma Physics Laboratory, Princeton, NJ (USA) (1986). (CONF-860324–: 6. topical conference on high temperature plasma diagnostics, Hilton Head Island, SC (USA), 9-13 Mar 1986).

Diagnostic data acquisition on Princeton's tokamac fusion test reactor (TFTR) is accomplished via CAMAC (computer automated measurement and control system). This paper describes the capabilities of this instrumentation technique as applied to TFTR diagnostics. The authors present the family of CAMAC modules and equipment necessary for TFTR data acquisition and process control. These modules provide system configuration that ranges from meeting the basic requirements of digital and analog input/output to the more exotic requirements afforded by special modules. The special modules include transient digitizers, scalars, histogrammers (each with add-on memory storage), timing and sequencing and time gate units, function generators, and microprocessor interface units. The authors describe the applications, guidelines, and recommendations that have directly evolved from system configurations based on their experience with TFTR CAMAC.

29833 Global resistance MHD calculations for high-beta DIII-D divertor tokamak. Lee, J.K. (General Atomics Co., San Diego, CA (USA)); Strait, E.J.; Lao, L.L.; Taylor, T.S. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Resistive MHD phenomena at high pressure or high current may cause magnetic fluctuations and determine various discharge limitations for tokamaks. The linear and nonlinear resistive MHD phenomena for finite-β (β is the ratio of plasma pressure to toroidal magnetic field energy) noncircular tokamak equilibria are studied using a 3-D initial value code CART. This code, employing Cartesian coordinate mesh, is particularly suited for treating noncirvular shapes, updown asymmetry, open field lines and a magnetic separatirix, all of which characterize realistic DIII-D single-null divertor discharges with high pressure or high current. More than two dozen magnetic signals calculated from inferred profiles show a good agreement with the measurements both in relative amplitudes and phases when the vacuum vessel is treated as conducting and its exact noncircular shape is taken into account. With a simple modeling of finite Larmor radius effect, these calculations suggest that the prevailing mode structure of the pressure-driven resistive mode might change from short to long wavelength (namely, from toroidal mode number n = 3 to n = 1) as the plasma pressure is increased, in accordance with experimental observation. The line-typing effect in terms of reduced resistivity in open field lines and the localized change in the interior resistivity due to local heating are found to have some weak effect on these global resistive MHD modes for the DIII-D plasmas. The effects of a magnetic separatrix and its x-point location are also examined.

29834 A compact and low power microwave ECR broad ion beam source for low pressure materials processing. Mahoney, L. (Michigan State Univ., East Lansing, MI (USA)); Asmussen, J. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Earlier work has demonstrated a multicusp, ECR ion cource concept using a seven-inch cavity applicator. However, many industrial and research applications desire a physically compact, long life and high current density broad beam ion source capable of operating with chemically active gases such as CF_4 and O_2. The multicusp ECR ion source concept has been redesigned to increase output beam current while reducing its physical size. The following design improvements have been implemented: the physical size of the cylindrical applicator has been reduced to an OD of 3.75 inches and a cavity ID of 3.5 inches while retaining a discharge diameter of 5 cm, the multicusp magnets have been removed from the microwave excitation region, improved water and gas cooling allow for higher power (>200W) operation, the double extraction grids have been redesigned for greater transparency and hence greater beam current densities and the discharge is now self-starting at low pressures. The measured experimental performance indicates that when excited with the TE 111 mode at 2.45 GH_z, this source operates efficiently and easily at low imput gas flows (1-5 sccm) and pressures in Ar, O_2 and N_2 gases. The detailed experimental operation of this new ion beam source is reviewed.

29835 Carbon pellet cloud striations. Parks, P.B. (General Atomics Co., San Diego, CA (USA)). pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Fine scale striations, with alternating rows of bright and dark zones, have been observed in the ablation clouds of carbon pellets injected into the TEXT tokamak. The striations extend along the magnetic field for about 1 cm with quite regular cross-field variations characterized by a wavelength of a few mm. Their potential as a diagnostic tool for measuring q-profiles in tokamaks provides motivation for investigating the origin of the striations. The authors propose that the striations are not due to a sequence of high and low ablation rates because of the finite thermal magnetic islands localized at rational surfaces, q = m/n, would be responsible for reducing the electron flux to the pellet region; the length of the closed field line which forms the local magnetic axis of the island is too long to prevent a depletion of plasma electrons in a flux tube intercepting the pellet for the duration $2_{rp}/_{vp}$. Instead, they propose that striations are the manifestation of the saturated state of growing fluctuations inside the cloud. The instability is generated by E x B rotation of the ablation cloud. The outward centrifugal force points down the ablation density gradient inducing the Rayleigh-Taylor instability. The instability is not present for wave numbers along the field lines, which may explain why the striations are long and uniform in that direction. The E field deveiops inside the ablation cloud as a result of cold electron return currents which are induced to cancel the incoming hot plasma electron current streaming along the field lines.

29836 Changes in diode operating characteristics as a function of applied magnetic field geometry. Pregenzer, A.L. (Sandia National Labs., Albuquerque, NM (USA)); Woodworth, J.R.; Lockner, T.R.; Rosenthal, S.E.; Bieg, K.W.; Desjarlais, M.P.; Coats, R.S. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Bountiful, UT (USA) (1989). DOE Contract AC04-76DP00789. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

In order to propagate a lithium ion beam to the axis on PBFA II, a specific magnetic field geometry is required. If the ions lose no energy in the gas cell, and if lithium ions originate at the anode in the singly charged state and are stripped to the triply charged state in the gas cell membrane; conservation of canonical angular momentum requires that $\Psi_a = -2\Psi_g$. Here Ψ is the magnetic field stream function defined as $\Psi = rA\Theta$, where r is the radial position and $A\Theta$ is the Θ component of the vector potential in cylindrical coordinates. The subscripts a and g refer to the values of the stream function at the anode and the gas cell, respectively. If energy loss in the gas cell is taken into account, the factor of 2 increases to about 2.8 for 5 MeV lithium ions. Here, the authors present the experimental results and attempts to form a coherent picture of these results using both simulation and alalystic theory. Factors which are believed to be important are the anode surface area, the magnitude and uniformity of the magnetic insulation between the cathode tip and the active anode surface, the amount of radial magnetic flux in the diode feeds, and the magnetic field topology in the diode region. These factors may alter the dynamics of charge accumulation in the diode and thereby affect the timing of ion current enhancement.

29837 A computational Analysis of energy and mass transport in plasma skull melting processes. Brent, A.D. (Minnesota Univ., Minneapolis, MN (USA). Dept. of Civil and Mineral Engineering); Reid, K.J. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

In recent years, molten-bath plasma furnace technology has found increasing application in the metallurgical industries for both extractive and fabrication operations. This technology is inherently energy intensive and an understanding of the governing heat and mass transfer mechanisms is essential for the development of efficient plasma furnaces and optimal operational strategies. To augment an extensive experimental plasma research a mathematical modeling program has been initiated to provide computational capabilities applicable to process development, equipment design and process control of plasma reactors. The speed of numerical calculations allows the implications of a large number of design optimization procedure. An improved understanding of transport phenomena within plasma furnaces may also influence or change presently accepted operational strategies. The successful operation of a molten-bath plasma furnace hinges on correctly balancing power input, process energy requirements and heat losses. Control of this thermal balance is particularly critical in skull melting operations where the maintenance of an adequate freeze-lining is essential for avoiding both product contamination and crucible damage. The results of a computational analysis of heat transfer and fluid flow in the melt region of a titanium skull melting furnace are presented and the controlling mechanisms discussed. The mathematical model developed addresses the conjugate heat transfer, phase change and boundary condition aspects of the problem and applies state-of-the-art computational methods to provide numerical solutions to the governing equations. The relative influences of thermal buoyancy, thermocapillary and arc shear induced flow on both the melt pool volume and skull profile are examined. Interactions between the flow effects are analyzed and discussed.

29838 The potential of D-T and D-^{3}He fuel cycles in field-reversed configurations. Kernbichler, W. (AEP, Graz University of Technology (AAT)); Miley, G.H. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The field-reversed configuration (FRC) is a possible direction for future fusion experiments and reactor development. Its potential for either D-T or D-^{3}He operation and the implication of the fuel choice on necessary reactor parameters (size, field, reversal factor,...) are the objective of the study reported in this paper. The high $\langle\beta\rangle$ and the divertor action of the open field lines are especially attractive for high power density operation and for direct energy conversion. The compact design, the cylindrical geometry, and the possibility of a translating the plassmoid from the formation chamber to the burn chamber are added positive features. Also theoretical studies indicates that charged fusion products can generate significant plasma current due to preferential loss directions. This, together with pellet injection may maintain sufficient current to sustain steady-state. Due to the early stage of development and the low effort compared to mainline devices, many problems are unsolved. A key one is particle and energy transport, unsolved. A key one is particle and energy transport, where several models offer different scaling laws. They range from the upper limit given by the loss sphere scattering model to more pessimistic laws based on anomalous lower hybrid transport. In the present study the authors use the loss sphere model by fitting it to the limited data base available and compare the results with other scaling laws. The emphasis here is the energetic and nuclear performance of both D-T and a D-^{3}He fueled plasmas in such a device. A profile averaged O-D plasma model is used which includes all relevant physical processes.

29839 Ohmic and alpha heating in the high-field IGNITEX Tokamak. Bickerton, R. (Texas Univ., Austin, TX (USA)); Fu, G.; Carrera, R.; Dong, J.; Montalvo, E.; Ordonez, C.; Tamor, S.; Van Dam, J.; Helton, J.; Hively, L. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The fusion ignition experiment IGNITEX will utilize a single-turn coil tokamak to produce and control ignited plasmas for scientific study. The special design characteristics of the IGNITEX device should permit a toroidal field on plasma-axis of 20 T and plasma currents of 12 MA during a 5 s flat top (about 10 energy confinement times). The pulse length is extended to a total of 10 s by precooling the magnet structure to liquid nitrogen temperature. The fusion ignition experiment IGNITEX should: 1) prove the scientific feasibility of controlled thermonuclear fusion, 2) permit the study of a new regime of physics: ignited plasma, 3) provide scientific knowledge for the design of future fusion systems, and 4) show how to produce and control fusion energy.

29840 First wall system in the IGNITEX experiment. Ordonez, C.A. (Texas Univ., Austin, TX (USA)); Carrera, R.; Chen, Y.; Howell, J.; Varghese, P. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Computer simulations to determine wall loading and surface response (e.g. recycling, sputtering and sublimitation) for the proposed ignition experiment, IGNITEX, are presented. The IGNITEX tokamak will ohmically heat a deuterium-tritium plasma to thermonu-clear, fusion ignition conditions. A single-turn coil will be used to produce a 20 Tesla toroidal field for plasma confinement. The first wall will be flat and limiterless with breaks for diagnostic and vacuum ports. The wall will consist of an amorphous carbon film applied to a thick beryllium coating which is plasma jet sprayed onto the vacuum vessel. The carbon film is applied between discharges (by the technique of carbonization) in order to: redeposit carbon eroded during the previous discharge, cover helium ash and other deposited impurities, and regulate the isotope ratio of desorbed, recycled hydrogen. Remote maintenance of areas strongly eroded by major disruptions will be carried out by beryllium plasma jet spraying with a robotic arm. During an ignited plasma discharge, the wall will be exposed to fluxes of neutrons, alpha particles, charge-exchange neutral atoms, photons, and plasma ions and electrons. The response of the wall surface to these fluxes will affect the operation of the machine. Two different time scales are considered in the analysis.

29841 Effects of the velocity-space particle loss on the behavior of field-reversed configurations. Hsiao, M.Y. (Pennsylvania State Univ., University Park, PA (USA). Dept. of Nuclear Engineering); Chiang, P.R. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

Field-reversed configurations (FRCs) have been observed to be stable for many Alfven times. However, the complete consistencies between experiments and theories have not been established. One important issue which has not been well studied or measured is the electric field. Recently, an electric potential profile in the edge layer has been suggested to explain the unusually broad edge layer. The electric field due to the velocity-space particle loss (VSPL) has also been calculated for FRCs. The VSPL-induced electric field may be an important factor in resolving some of the remaining issues in FRCs. The electric current profiles in the presence of the velocity-space particle loss are calculated. A shelf-consistent one-dimensional magnetic field is obtained by solving Ampere's law. The electric field structure developed from the VSPL mechanism is used to explain the origin of the rotation and the unusually broad edge layer. For the origin of the rotation, quantitative calculations of the stable period are given. A finite-loss-time model for the unconfined particles is suggested to justify the importance of the VSPL. Qualitatively, the dependences of the stable period on the experimental parameters such as temperature, magnetic field, density, and plasma length are consistent with the VSPL predictions. Quantitative results also show certain consistencies. For the edge layer, the density contribution from the energetic ions are calculated including the effects of the electric field. It is found that, due to the effect of the VSPL electric field, the density contribution from the energetic ions can be up to 1/3 to 1/2 of the density in the edge layer, depending on the operating parameters of FRCs.

29842 Non-equilibrium behavior of low-pressure plasma jets. Chang, C.H. (Minnesota Univ., Minneapolis, MN (USA). Dept. of Mechanical Engineering); Pfender, E. pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

After establishing the basic equations, some sample calculations are presented to examine the thermodynamic state of the plasma from atmospheric to low pressures (80 mbar). These results indicate the validity of local thermodynamic equilibrium (LTE) at atmospheric pressure as well as strong deviations from LTE at lower pressures especially in terms of chemical equilibrium. Departures from kinetic equilibrium are not as severe as those from chemical equilibrium along the centerline of the jet. However, there are some departures from transitional equilibrium in the fringes of the jet. It is demonstrated that conventional methods based on the LTE assumption are not appropriate for describing low-pressure plasma jets.

29843 NET II simulation of a pulse forming line (PFL) with spark gap and load. Hollmann, B.Z. (Naval Surface Weapons Center, Dahlgren, VA (USA)). pp. 758 of Proceedings of the sixth IEEE pulsed power conference (technical papers). Bernstein, B. H.; Turchi, P. J. IEEE Service Center, Piscataway, NJ (USA) (1987). (CONF-870656–: 6. Institute of Electrical and Electronic Engineers pulsed power conference, Arlington, VA (USA), 29 Jun - 1 jul 1987).

In this paper, the authors report on the NET II simulation. The purpose of this NET II simulation is to understand the operation of a spark gap switch in series with a resistive liquid load at the output of a pulse forming line (PFL), fed by a specified power supply. A series of runs simulated a shorted spark gap at the output of a PFL fed by a Marx generator. Comparing results with experimental data, it was inferred that the load resistance is less than the PFL's impedance, and with considerable inductance. The authors seek a load inductance as close to zero as possible.

29844 Impact of high magnetic fields on fusion systems. Cohn, D.R. (Massachusetts Inst. of Tech., Cambridge, MA (USA)). pp. 2950 of Proceedings of the 24th intersociety energy conversion engineering conference. Volume 6. IEEE Service Center, Piscataway, NJ (USA) (1989). (CONF-890815–: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989).

Paper 899532.

High field concepts can provide significant advantages for the size and performance of tokamak fusion reactors. These devices would make use of advanced superconductors and structural materials. Use of high plasma aspect ratios, super high field operation, and strong ohmic heating are promising new directions. The tokamak device has been demonstrated to be the most effective magnetic confinement machine for obtaining the burning plasma conditions required for a fusion reactor. Analysis of present experimental results together with basic theoretical considerations indicates that high magnetic fields can have a large beneficial impact on reactor performance and cost. At the same time superconducting magnet technology has been steadily advancing. Concepts that maximize the beneficial impacts of high fields and make use of advanced superconducting magnet technology could thus have a profound impact on the development of fusion systems. In this paper the authors discuss this approach and describe some promising directions.

29845 Neoclassical transport of isotropic fast ions. Hsu, C.T. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (US)); Catto, P.J.; Sigmar, D.J. *Physics of Fluids B (USA)*, 2(2): 280-290 (Feb 1990). DOE Contract AC02-78ET51013;FG02-88ER53263.

A study of radial gradient-driven neoclassical transport of fast ions, produced by an isotropic source in an axisymmetric toroidal system, is presented. The governing equation is a flux surface averaged Fokker–Planck equation that retains both the effects of the pitch angle scattering and drag. It is solved by utilizing an eigenfunction technique in conjunction with a rigorous numerical treatment. The results, which are valid for finite inverse-aspect-ratio ϵ, are found to fall between the previous limiting calculations [Nucl. Fusion **15**, 359 (1975); Phys. Rev. Lett. **60**, 1954 (1988)] for most of the relevant parameter regimes.

29846 Stationary flow model of ablatively imploded spherical shells. Montierth, L.M. (Los Alamos National Laboratory, X-1, E531, Los Alamos, New Mexico 87545 (US)); Morse, R.L. *Physics of Fluids B (USA)*, 2(2): 353-370 (Feb 1990).

The stationary flow model of spherical ablation is extended to shells, solutions with a density discontinuity at the critical surface, and charged-particle-beam-driven ablation. Parameter studies of the shell solutions show the relationship between shell aspect ratio, relative ablative mass removal or burnthrough, laser power, and shell material type. The discontinuous solutions are shown to occur when the critical surface and sonic surface coalesce. The relationship of these discontinuous solutions to particular physical situations is shown to be ambiguous in a way that must be resolved by microscopic transport calculations. Charged-particle-driven ablative implosion processes are shown to resemble laser-driven ablation. However, qualitatively different ablation processes occur in different regimes of the power and particle range of the incident beam. Procedures are described by which stationary solutions can be used to predict and interpret the results of experiments and numerical simulations.

29847 The theory of final focusing of intense light ion beams. Watrous, J. (Plasma Technology Branch, Naval Research Laboratory, Washington DC 20375 (US)); Ottinger, P.F.; Mosher, D. *Physics of Fluids B (USA)*, 2(2): 378-389 (Feb 1990).

Efficient transport of the high-power light ion beams of interest to inertial confinement fusion (ICF) experiments may require the use of large radius transport channels. The mismatch in the radii of the transported ion beam and the ICF target requires that the beam be focused following transport. A theoretical description of intense light ion beam focusing with a *z*-discharge plasma is presented. The theory is based on a Vlasov equation description of a fully charge- and current-neutralized ion beam, neglecting any angular momentum of the beam ions. An initial ion beam phase-space distribution with adjustable parameters is considered so that its effect upon the phase-space distribution at the focal plane can be analyzed. A numerical code is used to analyze the effect of angular momentum on the focusing properties of the final focusing cell. The theoretical analysis gives expressions for the focal length, for the discharge current required to produce a given degree of focusing, and for the radial number density profiles at the focal plane. The analysis of angular momentum indicates that the focal length and focusing current are not strongly affected even when beam ions have a significant amount of angular momentum.

99 GENERAL AND MISCELLANEOUS

29848 (CONF-9004177–1) **Understanding the computing system domain of advanced computing with microcomputers.** Hake, K.A. Oak Ridge National Lab., TN (USA). [1990]. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Advanced computing for the social sciences conference; Williamsburg, VA (USA); 10-12 Apr 1990. Order Number DE90009825. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Accepting the challenge by the Executive Office of the President, Office of Science and Technology Policy for research to keep pace with technology, the author surveys the knowledge domain of advanced microcomputers. The paper provides a general background for social scientists in technology traditionally relegated to computer science and engineering. The concept of systems integration serves as a framework of understanding for the various elements of the knowledge domain of advanced microcomputing. The systems integration framework is viewed as a series of interrelated building blocks composed of the domain elements. These elements are: the processor platform, operating system, display technology, mass storage, application software, and human-computer interface. References come from recent articles in popular magazines and journals to help emphasize the easy access of this information, its appropriate technical level for the social scientist, and its transient currency. 78 refs., 3 figs.

29849 (CONF-9005106–) **13th Department of Energy Computer Security Group conference "Security through teamwork": Proceedings.** USDOE Office of Administration and Human Resource Management, Washington, DC (USA). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Assistant Secretary for Defense Programs, Washington, DC (USA). Office of Safeguards and Security. [1990]. 206p. Sponsored by U.S. DOE Defense Programs. From 13. Department of Energy computer security group conference: security through teamwork; Augusta, GA (USA); 8-10 May 1990. Order Number DE90010251. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

We live in a world of Personal Computers. Some are simply stand-alone, yet some connect to mainframes or even networks and modems, and the number of PCs used is on the rise. Along with the notable increase in microprocessors, Computer Security issues and concerns for computing resources have multiplied. Questions have arisen, such as: What PC hardware and software products do we have at our Site? Which PCs connect to modems? Where, specifically, are all of our word processors, and who are the CSSOs for these systems? With these challenges in mind, Mason and Hanger, Silas Mason Co., Inc., at Pantex Plant, developed an in house program for keeping track of all security plan and system inventory information for each workstation on site. The program is used for CSSOs to maintain information on the systems within their area of responsibility. Whenever the CSSI makes a change to a plan(s), the program creates an update diskette for the CSSM/CPPM to use in maintaining a master database of current security plan addendums. The program also generated five local forms: the Security Plan Addendum, a Contingency Plan and Risk Analysis, a Hardware and Software Inventory report, Modem Requests, and a Material Move Order. These forms supplement the local Master Security Plan for Microprocessors.

29850 (INIS-XN–199) **NEA Activities in 1988.** Nuclear Energy Agency, 75 - Paris (France). 1989. 51p. Order Number DE90625258. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

The following topics are developed: trends in nuclear power; nuclear development and the fuel cycle; nuclear safety and licensing; radiation protection; radioactive waste management; legal affairs; nuclear science; NEA joint projects; information programmes.

29851 (UJV–8682-V) **Progress report for '88.** Havelka, S. (ed.) (and others). Ustav Jaderneho Vyzkumu CSKAE, Rez (Czechoslovakia). Feb 1989. 64p. (In Czech). Order Number DE90625058. Available from NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS.

Results are reported of nuclear power research including reactor physics, reactor materials, reactor technology, fuel cycle chemistry; of research in ionizing radiation applications including radiation technologies, radiopharmaceuticals, neutron activation analysis, neutron radiography. Services are outlined provided by the UJV, such as the production of radiopharmaceuticals, development and manufacture of semiconductor radiation detectors, irradiation services, data processing services, library and information centre services. (E.J.). 38 figs., 7 tabs., 107 refs.

29852 (UTRCN-G–18) **Report on progress of researches by common utilization of JAERI nuclear facilities, for fiscal 1988.** Tokyo Univ. (Japan). Research Center for Nuclear Science and Technology. 1989. 367p. (In Japanese). Order Number DE90777886. Available from NTIS (US Sales Only), PC A16/MF A01.

In 1988, this system called 'Common utilization of JAERI facilities' so far was changed to 'Joint research utilizing JAERI facilities', and by evaluating more positively the function of the General Research Center for Nuclear Energy, it has been emphasized to promote and coordinate the joint research among universities centering around the utilization of JAERI facilities. The total number of the research subjects in fiscal year 1988 reached 138, but the results of 120 of them are collected in this book. General joint research is the standard form of the utilization of various facilities that JAERI has opened to common utilization. Cooperation research is to be carried out by concluding research cooperation contracts between university researchers and JAERI researchers, and the facilities which are not opened to common utilization can be used. In the general joint research, the utilization of irradiation such as activation analysis, radiochemistry, irradiation effect, neutron diffraction and so on and the research using beams are mostly carried out, but in the cooperation research, reactor engineering, reactor materials,, nuclear physics measurement and so on are the main subjects. The total number of visitors in one year was 3829 man-day. (K.I.).

9901 Management

Refer also to citation(s) 27767, 28707, 28711, 29931

29853 (EGG-M–90062) **MORT [Management Oversight and Risk Tree] based risk management.** Briscoe, G.J. EG and G Idaho, Inc., Idaho Falls, ID (USA). Feb 1990. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-8909290–2: Risk management symposium, Whippany, NJ (USA), 6-7 Sep 1989). Order Number DE90009620. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Risk Management is the optimization of safety programs. This requires a formal systems approach to hazards identification, risk quantification, and resource allocation/risk acceptance as opposed to case-by-case decisions. The Management Oversight and Risk Tree (MORT) has gained wide acceptance as a comprehensive formal systems approach covering all aspects of risk management. It (MORT) is a comprehensive analytical procedure that provides a disciplined method for determining the causes and contributing factors of major accidents. Alternatively, it serves as a tool to evaluate the quality of an existing safety system. While similar in many respects to fault tree analysis, MORT is more generalized and presents over 1500 specific elements of an ideal "universal" management program for optimizing occupational safety.

29854 (ORNL/Sub–7685/1-T23) **Evacuation of institutionalized and specialized populations.** Vogt, B.M. (Tennessee Univ., Knoxville, TN (USA)). Oak Ridge National Lab., TN (USA). Feb 1990. 104p. Sponsored by U.S. Federal Emergency Management Agency. DOE Contract AC05-84OR21400. Order Number DE90007967. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The purpose of this research was to assess the needs of organizations caring for institutional and specialized populations when faced with a threat or hazard requiring an evacuation. Individuals within specialized populations are unlike other victims of disaster because of their inherent dependency on organizational care givers and require different management strategies on the part of organizations and agencies in an evacuation. The research sought to identify those aspects of coping strategies that have been used

successfully to manage an emergency evacuation. To identify special populations that have evacuated from institutions and similar facilities over a four-year period, a computerized search was conducted of media accounts describing such events. The search yielded a total of 1024 accounts from which four major subgroups were identified: nursing homes and related care facilities, hospitals, educational institutions, and correctional facilities. A miscellaneous group including housing for the elderly, apartments and other building complexes, workplaces and factories, public facilities, and places occupied by transient populations, such as transportation units and recreational facilities, could be used for future study. Among the factors found to affect evacuations were the extent of organizational resources (such as the number of staff or other individuals available at the time of the event), the type and number of clientele, and such community characteristics as population density. The study focuses on selected organizational characteristics of health care facilities (nursing homes and related care facilities and hospitals) which have recently experienced either a partial or complete evacuation of their facilities. 165 refs., 13 tabs.

29855 (PNL-MA–70-Vol.1) **Procedures for Quality Assurance Program: Volume 1.** Shaub, R.L.; Ryder, D.E. Pacific Northwest Lab., Richland, WA (USA). Dec 1989. 384p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-76RL01830. Order Number DE90010001. Available from NTIS, PC A17/MF A01 - OSTI; GPO Dep.

These administrative procedures have been developed to implement the quality assurance program described in PNL-MA-70, Quality Assurance Manual. The manual and procedures establish requirements, responsibilities, and methods for execution of the program consistent with US Department of Energy (DOE) policies and requirements. When specified by a QA Plan, a Statement of Work or other governing document, PNL activities affecting quality shall be performed in accordance with the administrative procedures. The procedures are controlled documents assigned to the person named on the cover sheet. The assignee is responsible for maintaining the procedures in an up-to-date condition, consistent with Controlled Document Lists, by incorporating subsequent changes or new procedures promptly as they are issued. These procedures shall be available and used at the location where the prescribed activity is performed. A Controlled Document List (CDL) for each type of administrative procedure is included for use as a table of contents. The CDL lists procedure numbers, titles, revisions and/or amendments and the effective date. Work shall be performed in accordance with the latest effective procedure revision and/or amendment identified in the CDL unless a Controlled Document Transmittal Record (CDT/R), a QA Plan, or a Statement of Work allows or requires otherwise. This document is Volume 1 of a two volume set.

29856 (PNL-MA–70-Vol.2) **Procedures for Quality Assurance Program—QAPs: Volume 2.** Shaub, R.L.; Ryder, D.E. Pacific Northwest Lab., Richland, WA (USA). Dec 1989. 94p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC06-76RL01830. Order Number DE90010000. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

These administrative procedures have been developed to implement the quality assurance program described in PNL-MA-70, Quality Assurance Manual. The manual and procedures establish requirements, responsibilities, and methods for execution of the program consistent with US Department of Energy (DOE) policies and requirements. When specified by a QA Plan, a Statement of Work or other governing document, PNL activities affecting quality shall be performed in accordance with the administrative procedures. The procedures are controlled documents assigned to the person named on the cover sheet. The assignee is responsible for maintaining the procedures in an up-to-date condition, consistent with Controlled Document Lists, by incorporating subsequent changes or new procedures promptly as they are issued. These procedures shall be available and used at the location where the prescribed activity is performed. A Controlled Document List (CDL) for each type of administrative procedure is included for use as a table of contents. The CDL lists procedure numbers, titles, revisions and/or amendments and the effective date. Work shall be performed in accordance with the latest effective procedure revision and/or amendment identified in the CDL unless a Controllable Document Transmittal Record (CDT/R), a QA Plan, or a Statement of Work allows or requires otherwise. This document is Volume 2 of a two volume set.

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29857 (AD-A–216433/3/XAB) **Distributed decomposition of block-angular linear programs on a Hypercube computer.** Ho, J.K.; Gnanendran, S.K. Tennessee Univ., Knoxville, TN (USA). Management Science Program. Jul 1989. 27p. (MSP–89-3). Available from NTIS, PC A03/MF A01.

Algorithms based on the Dantzig-Wolfe decomposition principle for linear programs are implemented on an Intel iPSC-2 Hypercube computer with 64-processors. Computational results with block-angular linear programs from diverse applications are reported. They indicate that the approach of distributed computation on relatively inexpensive multiple processor computers may be very cost-effective for large, structured linear programs. It is also shown that by studying certain characteristics of the interaction among the master and subproblems, one can select algorithms that best exploit the parallel processing environment.

29858 (AD-A–216452/3/XAB) **DARPA/ISTO (Defense Advanced Research Projects Agency/Information Science and Technology Office) quarterly report. Report for 1 April-30 June 1989.** Reif, J.H. Duke Univ., Durham, NC (USA). 1 Jul 1989. 16p. Available from NTIS, PC A03/MF A01.

A system of rules and techniques is developed for derivation of various classes of parallel algorithms including: (1) Systolic algorithms for various fixed connection networks; (2) Randomized parallel algorithms; (3) Parallel algorithms for tree and graph problems; and (4) Parallel algorithms for algebraic problems. The development is emphasized of fundamental derivation techniques that can be utilized in as wide a class of parallel algorithms as possible. The specific algorithms to be derived have themselves been carefully chosen to be as fundamental as possible. Algorithms and areas currently under investigation include: parallel list ranking, parallel graph connectivity, automatic parallel compilation from segmented straight-line programs, and derivation of pipelined algorithms for small-diameter networks.

29859 (AD-A–216579/3/XAB) **Speculative computation in Multilisp. Master's thesis.** Osborne, R.B. Massachusetts Inst. of Tech., Cambridge, MA (USA). Lab. for Computer Science. Dec 1989. 266p. (MIT/LCS/TR–464). Available from NTIS, PC A12/MF A02.

This thesis demonstrates by experiments, that performing computations in parallel before their results are known to be required can yield performance improvements over conventional approaches to parallel computing. We call such eager computation of expressions speculative computation, as opposed to conventional mandatory computation that is used in almost all contemporary parallel programming languages and systems. The major requirements for speculative computation are a means to control computation to favor the most promising computations, and a

means to abort computation and reclaim computation resources. We investigate these requirements in the parallel symbolic language Multilisp and conclude that we need the following support for speculative computation: for controlling computation we need ordering (ranking of computations by their promise), demand transitivity, and modularity, and for reclaiming computation we need explicit, reversible reclamation with automatic naming of descendants. The main contribution of this work is a sponsor model which provides this support for speculative computation in Multilisp. A sponsor is an agent which controls the allocation of resources to computation. This sponsor model handles control and reclamation of computation in a single, elegant framework. We also discuss the optimal scheduling of speculative computation and present new results for optimal scheduling in simple cases.

29860 (AD-A-216581/9/XAB) **High-level connectionist models. Semiannual report.** Pollack, J.B. Ohio State Univ., Columbus, OH (USA). Dept. of Computer and Information Science. Aug 1989. 87p. Available from NTIS, PC A05/MF A01.

The major achievement of this semiannum was the significant revision and extension of the Recursive Auto-Associative Memory (RAAM) work for publication in the journal Artificial Intelligence. Included as an appendix to this report, the article includes several new elements: (1) Background - The work was more clearly set into the area of recursive distributed representations, machine learning, and the adequacy of the connectionist approach for high-level cognitive modeling; (2) New Experiment - RAAM was applied to finding compact representations for sequences of letters; (3) Analysis - The developed representations were analyzed as features which range from categorical to distinctive. Categorical features distinguish between conceptual categories while distinctive features vary within categories and discriminate or label the members. The representations were also analyzed geometrically; and (4) Applications - Feasibility studies were performed and described on inference by association, and on using RAAM-generated patterns along with cascaded networks for natural language parsing. Both of these remain long-term goals of the project.

29861 (AD-A-216663/5/XAB) **Center for the integration of optical computing. Final technical report, 1 October 1986-30 September 1989.** Sawchuk, A.A.; Steier, W.H. University of Southern California, Los Angeles, CA (USA). Dept. of Electrical Engineering. 30 Nov 1989. 67p. Available from NTIS, PC A04/MF A01.

This report summarizes the research progress in the 3-year period in the area of integrated optical computing. The topics include: dynamic optical interconnections, low threshold laser arrays, array receivers, neural computation vision algorithms, lenslet array processors, neural net photonic architectures, Fabry-Perot spatial light modulators, optical associative memories, opto-optical switching, MQW spatial light modulators, and volume holographic optical elements.

29862 (AD-A-216747/6/XAB) **High-performance computer-programming environments. Final report, 1 October 1987-30 September 1988.** Snyder, L.; Notkin, D. Washington Univ., Seattle, WA (USA). Dept. of Computer Science. 30 Sep 1988. 10p. Available from NTIS, PC A02/MF A01.

This one year grant had the primary goal of the assessment of the Poker Parallel Programming environment and the planning and design of new parallel programming environment. These goals were achieved. The new programming environment, to be built on a software platform that permits rapid prototyping of alternative environments, was designed using a three level language abstraction. The central publications include the assessment of Poker, two papers on prototype graphic debugging environment, and two papers on parallel computer structures.

29863 (AD-A-216812/8/XAB) **Numerical algorithms for parallel computers. Final technical report, 1 May 1986-31 August 1989.** Adams, L.M. Washington Univ., Seattle, WA (USA). Dept. of Applied Mathematics. 31 Aug 1989. 11p. Available from NTIS, PC A03/MF A01.

Throughout the duration of this grant, progress has been made on five fronts: analysis of parallel iterative methods using Fourier analysis techniques, preconditioners for linear systems on parallel architectures, numerical grid generation algorithms for fighter aircraft configurations, parallel domain decomposition algorithms for symmetric eigenvalue problems, and parallel language design issues from an applications point of view.

29864 (AD-A-217056/1/XAB) **Semi-iterative methods on distributed-memory multiprocessor architectures.** Hadjidimos, A.; Houstis, E.N.; Rice, J.R.; Samaratzis, M.K.; Vavalis, E.A. Purdue Univ., Lafayette, IN (USA). Dept. of Computer Science. 1989. 10p. Available from NTIS, PC A02/MF A01.

In the parallel ELLPACK (//ELLPACK) project we are developing a library of parallel iterative methods for distributed memory multiprocessor systems and software tools for partitioning and allocation of the underlying computations. In this paper we discuss the implementation issues within the //ELLPACK environment and present preliminary performance results of some of the modules on three hypercube based architectures: NCUBE, iPSC/1 and iPSC/2. These results indicate that the iterative methods are capable of delivering close to optimal scaled speedups while the combination of concurrent/vector processing can lead to sizable improvements of the overall performance. These experiments have shown that distributed memory systems are capable of solving significantly large problems effectively.

29865 (ANL-89/43, pp. 27-50) **A position on multiprocessing in prolog.** Keller, R.M. (Univ. of California, Davis (USA)). Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372-: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

Multiprocessors appear most useful for applications such as robotics, vision, signal processing, hypothetical reasoning, optimization, and simulation. Currently several impediments still exist to effective use of multiprocessors. Most software tools are neither portable nor widely available and languages do not exploit multiprocessing capabilities. Logic programming currently is not the choice for most applications. One reason is that in many SIMD applications, logic programming provides no leverage. Logic programming is also just as cumbersome as C for large programs. An additional concern is, which approach to use: explicit communication (like Strand), restricted and parallelism, bilingualism, etc. Deductive databases offer the advantages of efficient compilation and optimization. They are now used for rapid prototyping. A gap still exists between large-scale database systems and database research. U.S. researchers are also not generally receptive to the idea of deductive databases. What does the future hold? More work is needed in debugging, performance evaluation, programming environments tuned for constraint programming, sub-Turing languages, and user-defined constraint domains.

29866 (ANL-89/43, pp. 51-56) **Developing the parallel inference machine.** Goto, Atsuhiro (Institute for New Generation Computer Technology, Tokyo (Japan)). Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372-: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

In the Japanese Fifth Generation Computer Systems project, parallel inference machine (PIM) systems are developed based on logic programming. The aim is to realize very high execution performance (say, 100 times the performance of current machines). The design involves implementation of a logic programming language, KL1, and a new operating system. Several pilot PIM machines are being developed; one will include up to 512 processor elements communicating through shared memory. The processor architecture has incorporated various innovative features to suit concurrent logic programming languages. For example, the processor design is based on a tagged architecture. Macro-call instructions permit subroutine calls for polymorphic operations required by high-level languages such as logic programming. Dedicated instructions are introduced to support incremental garbage collection. 17 refs.

29867 (ANL-89/43, pp. 57-60) **Future trends in database/logic programming.** Warren, D.S. Argonne National Lab., IL

(USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

Data-oriented problems are solved by a combination of code written in a programming language and code executed by a database system. The goal of recent research has been to put more capability into the database system. There are two obvious approaches to making a future database system with capability which now requires both an application programming language and a database. In the first approach, an object-oriented programming language is taken as the base, and capabilities are added. The object-oriented database inherits the procedures of the programming language; the notions of declarative specifications are essentially abandoned. In the second approach, a deductive database is enhanced by the addition of recursion; this has led to the development of datalog, a sublanguage of Prolog. Because the Prolog evaluation strategy is incomplete, datalog+ systems have explored bottom- up evaluation strategies (e.g., Magic Sets/ Templates). Unfortunately, there remains a serious optimization problem: users are reluctant to give up control to a system that cannot find the optimal way to evaluate every query. Needed is a compromise on control. For example, the programmer might give declarations (pragmas and annotations) that change the evaluation strategy but leave the semantics untouched. Such a compromise will require integration of various evaluation strategies; support of complex objects, tabulation, and caching; interactive program transformation; and incorporation of constraint logic programming.

29868 (ANL–89/43, pp. 61-64) **Report on parallel logic programming on the Multi-PSI.** Rokusawa, Kazuaki (Institute for New Generation Computer Technology, Tokyo (Japan)). Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

The Multi-PSI is a pilot parallel inference machine developed at ICOT in the second stage of the FGCS project. The purpose was to test new implementation techniques of concurrent logic languages, and to conduct research on parallel programming on a medium-scale parallel computer. Research activities cover parallel algorithms, parallel programming environments, language supports, and mapping (scheduling and data/load distribution). Research confirms the gap between concurrent logic programs and the parallel machines. A program in a concurrent logic language defines data dependency and possible parallelism, but does not address how the logical concurrency is embodied as physical parallelism. Mapping is especially important for loosely coupled architectures, in which data access cannot be assumed to be of uniform cost. The following approach was taken: (1) Pick a problem, design a concurrent algorithm, and write it in KL1. (2) Select a mapping strategy, run the program on the Multi-PSI. (3) Measure performance, analyze the results, and try new algorithms or new mapping strategies. The report covers four different types of problems: Packing piece puzzle (pentomino). A rectangular box and a collection of pieces with various shapes are given. We used a multilevel dynamic load balancing scheme. Speedups of 28.4 with 32 processors and 50 with 64 processors were obtained with the shortest path problem. Given a graph where each edge has an associated nonnegative cost and a start node in the graph, the problem is to find the minimum cost path to every node. Using a completely distributed algorithm with a priority mechanism, we studied strategies of mapping a large-scale grid graph (with 10^4 vertices) on large-scale MIMD machines with 100 processors. A Natural language parser problem is to construct all possible parse trees for an English sentence. The program called PAX does a bottom-up chart parsing. 5 refs.

29869 (ANL–89/43, pp. 65-74) **GenBank in nested relations.** Yokota, Kazumasa (Institute for New Generation Computer Technology, Tokyo (Japan)); Tanaka, Hidetoshi. Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

The purposes of database and knowledge base management systems at ICOT are to: (1) provide various knowledge information processing systems with database and knowledge base management facilities, and (2) make various experiments on next-generation intelligent database systems. To address these purposes, ICOT researchers are exploring two different types of projects. The Kappa system is an advanced database management system based on a nested relational model. The model includes the following features: List and bag constructors are used to control the sequence and cardinality of elements efficiently. Long image or text data can be stored. A program interface is user-definable. A constraint logic programming language CAL is used as generation or integrity rules for algebraic constraints between attributes. Semantic networks can be stored as is and manipulated by the corresponding database language. Main memory database management system is supported. A prototype Kappa system (60,000 lines) implemented in 1987 was released to some beta test sites. The second version (125,000 lines) was implemented in March 1989. A parallel version is currently under design and development. To date, one promising application has been the implementation of the GenBank database in Kappa. Four kinds of sequence databases have been loaded; invertebrate, virus, bacteria, and phage. We plan set up algorithms for homology searches, representation languages for secondary and tertiary structures, and extraction of motifs. 7 refs.

29870 (ANL–89/43, pp. 75-76) **Applied mathematics for digital systems.** Good, D.I. (Computational Logic, Inc., Austin, TX (USA)). Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

The absence of accurate mathematical models of the dynamic behavior of hardware and software systems increases risks of high developmental costs and operational malfunction. Computational Logic, Inc., is developing applied mathematics for digital systems. Precise mathematical models were produced for the dynamic behavior of some basic hardware and software systems, also proofs of the equivalence of these models. At the hardware level, two models were stated for the 32-bit FM8502 microprocessor (comparable to a PDP-11). The lowest-level hardware model is an interpreter for the gate-level state of the machine. The highest level is an interpreter for the machine language. Both interpreters are stated as total recursive functions in the Boyer-Moore logic. The two models were formally proved to be equivalent, and the proof was checked completely with the mechanical Boyer-Moore theorem prover. At the software level, a mathematical model of the behavior of programs in the Piton assembly language was similarly stated. An interpreter for Piton programs was stated as a total recursive function in the Boyer-Moore logic, and a compiler was implemented that compiles Piton into machine code. This compiler proved that the result of interpreting the compiled program on the FM85O2 interpreter is equivalent to interpreting the Piton program on the Piton interpreter. An interpreter also was stated for programs of the Micro Gypsy subset of the high-level Gypsy language, and a compiler for converting into Piton programs was set up. This compiler proved that the result of interpreting the compiled program on the Piton interpreter is equivalent to interpreting the Micro Gypsy program with its interpreter. A separate experiment was the implementation and proof of the KIT separation kernel for a machine similar to the FM85O2. 6 refs.

29871 (ANL–89/43, pp. 77-90) **Analysis of scalability of parallel algorithms.** Rao, V.N. (Univ. of Texas, Austin (USA)); Kumar, V. Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

Parallel processing opened a new dimension in the design an analysis of algorithms. But there is a wide gap between the theory

of parallel algorithms and the understanding of the performance of parallel algorithms on currently available multiprocessors. A new measure—the inefficiency function—is presented that captures the scalability of parallel algorithms. This measure is used in the study of three problems: solution of a wave equation, fluid flows simulation using flux corrected transport. And a parallel depth-first search for state-space trees. Inefficiency analysis has proved especially beneficial in: (1) identifying the scalability of parallel algorithms, (2) determining how fast a problem can be solved efficiently, (3) selecting an efficient parallel algorithm from among those reported in the literature, (4) deriving better work-distribution algorithms for shared-memory, ring, and hypercube architectures, (5) determining the best parallel architectures to solve a problem, and (6) studying parallel algorithms for problems believed to be beyond the class NC. 19 refs.

29872 (ANL–89/43, pp. 91-98) **Parallel logic programming algorithms for the bestpath problem.** Tick, E. Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

Six parallel logic programming algorithms are presented for solving the bestpath problem. This problem is a simple search problem concerning a graph. The graph is constructed of nodes and nondirected edges. Each edge connects two nodes, and a node is connected to at least one edge. A path is a route from one node to another, through an arbitrary number of edges. The cost of the path is the sum of the costs of the edges on the path. The problem is to find all minimum cost paths for a given starting node to each node in the graph. The six algorithms were as follows: (1) Dijkstra's sequential Prolog algorithm, (2) naive threshold pruning, (3) Overbeek's parallel boundary extension, (4) Tick's modification of the sequential algorithm using comparators, (5) Taki's monitor evaluation algorithm based on a data structure approach, and (6) Ichoyoshi's nearest-neighbor method based on a process structure approach. The algorithms were implemented in OK-parallel Prolog and Flat Guarded Horn Clauses (FGHC) and executed on a Sequent Symmetry with 1-15 processing elements. The results are interesting: even on 15 PEs, none of the programs beat the sequential Prolog program running on 1 PE. The closest are within 50% for the 1237-node graph. The two primary overheads reducing performance are the overhead of spawning small granularity tasks in OR-parallel Prolog, and the merge overhead of stream management in FGHC. These results point to areas of improvement for the system architectures. 4 refs.

29873 (ANL–89/43, pp. 99-112) **Strand: A practical parallel programming tool.** Foster, I. (Argonne National Lab., IL (USA)); Taylor, S. Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

Will logic programming ever reach the point where it is used to program real parallel applications on parallel machines? Contrary to common belief concurrent logic programming languages are already being used very effectively for this purpose. Two applications developed at Argonne— GenBank similarity searching and weather modeling—have used bilingual programming techniques to get substantial speedups over existing sequential codes. In these programs a concurrent logic language (Strand) is used to organize concurrent computations consisting of many sequential components. The sequential components are written in C or Fortran. Bilingual programming raises several issues that warrant further investigation—for example, efficiency in fine-grained implementations, and techniques for specifying and verifying interfaces between concurrent and sequential components. New tools also will be required to aid program development, especially for gathering and visualizing information about large-scale computations. 22 refs.

29874 (ANL–89/43, pp. 113-122) **DNA sequence knowledge base system (KNOA).** Konagaya, Akihiko (C and C Systems Research Labs., Kawasaki (Japan)); Yokota, Minoru. Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

Genetic information processing is being explored as part of the FGCS project. Logic programming has two principal advantages for genetic information processing: rapid prototyping and logical inference capabilities. Little is known about genetic information processing models, and new algorithms are constantly under review for analyzing more exact genetic models. Rapid prototyping is invaluable: demonstration of the feasibility of the algorithm is more important than performance. Logic programming greatly enhances prototyping because it provides high-level programming facilities for matching, inference, and database access. These facilities enable the researcher to concentrate his efforts on exploiting new algorithms concerning genetic information processing and to keep away from data management and complex execution control. The other important advantage of logic programming is that researchers can use logical inference. This feature is useful, for example, in homology searches, which involve identifying sequences that are similar to a target sequence in a data bank. The stochastic inductive inference can deal with the probable validity of an assertion even if it does not completely satisfy all the sequences in a superfamily, and even if it satisfies sequences that do not belong to the superfamily. A prototype DNA knowledge base system (KNOA) has been developed based on an inference machine with a fast Prolog processor and a large-scale main memory (320 Mbytes). The KNOA objective is an integrated system for genetic information processing in logic programming. Currently, GenBank, NBRF, and Protein Structure Data Bank have been implemented as collections of Prolog clauses. Several homology search algorithms are also available, and a prototypical secondary structure inference verification system developed. The system is useful in improving intuitive understanding of tertiary protein structures. 14 refs.

29875 (ANL–89/43, pp. 123-128) **Using logic programming to address computational problems in genetic sequence analysis.** Overbeek, R. (Argonne National Lab., IL (USA)). Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

Logic programming is a technology with much promise. Its strengths are integration of database issues with normal programming, expression of parallel algorithms, rapid prototyping capabilities, and high-level expression of constraints and solutions. Molecular biology is launching an endeavor that will require precisely these capabilities. To prove the feasibility, two prototypical problems were explored; interpretation of sequencing gels, and similarity searches. Gel interpretation involves five basic stages: obtaining a digitized image; normalizing the data; aligning the distinct lanes (using a standard gel); creating a set of vectors that represent intensity values for the four lanes; and interpreting the four vectors, producing a list of characters from (a, c, g, t). The task is easy by computer, requiring only a 2-3 page program and significantly reducing the time needed to interpret these gels. Similarity searches involve comparing a new protein sequence to other known sequences. A group at Argonne has devised a program which can align up to 500 sequences of length 2000. The code is based on bilingual programming in Strand and C, and runs efficiently on SIMD parallel processors. It is the first program to handle more than a few sequences (say, up to 10). The Argonne group has also studied exactly how covariance arguments are constructed. Too often, computer scientists have produced simplified algorithms that ignore the way biologists form their estimates. By imitating the human biologist, the Argonne group has produced tools that have obtained new results in biology: a secondary structure of 75, and bonds in the 165. Finally, the BioServe Project deserves note. This automatically aligns a set of sequences or inserts a new sequence into an existing alignment. The facility is available via electronic mail and is currently being used by researchers at the Center for Prokaryotic Genome Analysis.

29876 (ANL–89/43, pp. 129-140) **A connotative treatment of circumscription.** Akima, J. (ICOT Research Center, Tokyo (Japan)). Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

Circumscription proposed by McCarthy is a most promising formalizations of nonmonotonic aspects of common sense reasoning. Several versions proposed; still, are all for denotative minimization of predicates. That is, circumscription minimizes the extension of predicates. Researchers at ICOT have devised a connotative treatment of circumscription that overcomes three defective points of circumscription: absence of abnormal things, a limitation on equality, and inconsistency. Connotative circumscription is based on the idea of minimizing the set of names denoting objects that satisfy a certain predicate. The approach provides a form of the unique name assumption for a first-order sentence with functions and equality. Therefore, it is expected to contribute to declarative semantics for deductive database and logic programming with such sentences. 16 refs.

29877 (ANL–89/43, pp. 141-146) **EUODHILOS: interactive reasoning system for a variety of logics.** Minami, Toshiro (International Institute for Advanced Study of Social Information Science, Numazu (Japan)); Sawamura, Hajime. Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

EUODHILOS is a general-purpose reasoning assistant system with two characteristic features. One is its naturalness users can see and manipulate proof fragments interactively in a natural style as is used with paper and pencil. The other is its generality: EUODHILOS is logic-independent in the sense that the language and logic to be used are defined by its user. A logic in EUODHILOS has language and derivation systems. The user defines the language system, specifying characters to use and what strings of symbols are valid logical expressions. EUODHILOS will automatically generate a parser and unparser for the defined language, checks the validity of given external expressions, and translates them to the corresponding internal expressions. A derivation system in EUODHILOS has axioms and derivation rules. EUODHILOS will permit rewriting rules also inference rules as derivation rules. Well-known typical logics such as Hilbert's, Gentzen's, and equational can be treated within this framework. The system also supports the typical styles for reasoning: forward, backward, and a mixture. EUODHILOS intended as a reasoning assistant, involves interaction between the user and the system. Also, it can be used as a tool for computer-assisted instruction in logics and logical reasoning. 19 refs.

29878 (ANL–89/43, pp. 147-152) **Constraint solvers based on Groebner bases technique in CAL.** Sato, Yosuke (ICOT Research Center, Tokyo (Japan)). Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

Three constraint solvers are reviewed; complex domain, Boolean domain, and the domain of finite-cofinite sets. Each is based on Groebner bases techniques that satisfy two properties: (1) for any constraint, the solver tells us if it is satisfiable or not; and (2) if a constraint is satisfiable its solutions as a canonical form. Work is continuing on development of an efficient implementation or mathematical theory concerning the validity of the work in finite-cofinite sets. Future work will involve extending CAL to deal with Groebner bases as objects. 6 refs.

29879 (ANL–89/43, pp. 153-166) **Parametric queries, linear constraints, and variable elimination.** Lassez, J.L. (IBM T.J. Watson Research Center, Yorktown Heights, NY (USA)). Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

Various forms of declarative linear arithmetic are introduced in several languages from CLP(R) to Mathematical. To find canonical representations of constraints, to handle delays of nonlinear constraints, and to resolve guards in committed choice language and other related problems, anew and more powerful type of query must be answered: parametric linear queries. Proposed here is a simple mathematical formalism to address that problem. Fourier's variable elimination procedure and associated elementary theorems allow one to derive directly from their specification several interesting sets. For instance, one obtains the subsumption cone, which characterizes the set of all linear constraints implied by a set of linear constraints, the convex hull of a collection of polyhedral sets, the separability set that characterizes the hyperplanes separating two given polyhedral sets, and the set of answers to a given parametric query. If Fourier's variable elimination is a very powerful conceptual tool telling us what problems one can solve trivially in principle via variable elimination, it is generally impractical, as it generates for each variable eliminated an exponentially growing set of mostly redundant constraints. A new method is proposed for variable elimination that resets on a generalization of the notion of objective function in linear programming. It is more efficient than Fourier's procedure, as it bypasses all the costly intermediate steps and generates far less redundancy. This new method is to solve more efficiently the problem of implicit equalities—a key component in the computation of canonical representations of linear constraints. 15 refs.

29880 (ANL–89/43, pp. 167-172) **Candor - constraint and/or parallel logic language.** Hawley, D. Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

A group at ICOT is investigating constraint logic programming as a high-level paradigm for problem solving and knowledge representation. A new model, called Candor, is proposed based on the Andorra model and/or parallelism. Pure Andorra has semantics similar to Prolog, making it possible to benefit from analysis and transformation techniques applicable to Prolog, such as partial evaluation and abstract interpretation. Andorra, however, has the strategy prefer deterministic goals. The rule of choosing deterministic goals first is a good general heuristic because it often detect failure early, and it avoids redundant computation by delaying splitting the computation. A goal is deterministic if it has a maximum of one candidate clause that is satisfiable, based on the constraints in the head and body of the clauses. In Candor, there are three principal operations that are applicable to the respective three modes: and-reduction, or-extension, and block-splitting. The and-reduction and or-extension operations are similar to their counterparts in Andorra, except in that the mode transitions are different because of the introduction of blocks. The block-splitting operation is new; it provides a kind of lazy parallelism in which concurrent work can be done sequentially or in parallel, and that decision is made at the point of actually starting the work. Currently, the ICOT group has developed a very slow interpreter in KL1 for a subset of the language, and a couple of experimental KL1 implementations of the Buchberger algorithm have been made. Further work is needed on ways of expressing control and on design of the inter-solver interface. 13 refs.

29881 (ANL–89/43, pp. 173-192) **Design and implementation of LDL - a logic based language for data intensive applications.** Tsur, S. Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

Logical Data Language (LDL) is an attempt to combine the advantages of logic programming and relational data base

technology. Effort on the LDL started late in 1984, and is now approaching maturity with two efficient prototypes. Summary aspects of LDL programming include: (1) a more declarative style of programming, (2) a less artificial formulation of some rules and recursive predicates. (3) No meta-level predicates. (4) Programming techniques based on difference lists or the sharing of partially instantiated lists will not work. (5) Efficient storage or modification of data for later access is very useful. LDL is suitable for data intensive applications and interfaces to relational databases.

29882 (ANL–89/43, pp. 193-218) **Applications of LDL to scientific computing.** Tsur, S. (Microelectronics and Computer Technology Corp., Austin, TX (USA)). Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

Logical Data Language (LDL) is an attempt to combine the advantages of logic programming and relational data base technology. The LDL system has a language, a compiler/optimizer, a run time system that enables access to an in-memory object manager. The presentation covers; a general background and motivation for LDL, an application of LDL to complex data analysis problem, with an application to a synthesis problem. 6 figs.

29883 (ANL–89/43, pp. 219-222) **Elements necessary for the success of logic programming.** Bowen, K. Argonne National Lab., IL (USA). Dec 1989. (CONF-8910372–: Joint Japanese-American workshop on future trends in logic programming, Argonne, IL (USA), 11-13 Oct 1989). In *Joint Japanese-American workshop on future trends in logic programming.* Order Number DE90008343. Available from NTIS, PC A12.

Success of logic programming will be widespread use within a reasonable length of time (average life expectancy today). The necessary ingredients will be: (1) Solidity and reliability of both stand alone compiler and interactive development environments. And (2) Ability to serve everyday computing needs with relative ease and elegance including ability to; (a) run on a range of machines, (b) communicate in heterogeneous settings, (c) construct high-quality man-machine interfaces, (d) interface to a wide range of database management systems, and other packages. The paper examines other general points in some detail.

29884 (CONF-900652–1) **Symbolic pattern processing system for planar spatial structures.** Rao, N.S.V. Oak Ridge National Lab., TN (USA). 1990. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 10. international conference on pattern recognition; Atlantic City, NJ (USA); 17-21 Jun 1990. Order Number DE90001598. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We describe a symbolic pattern processing system that recognizes when composite planar structures are present in a two-dimensional spatial pattern. The composite objects are composed and identified by the arrangement of elementary objects (such as rectangles, squares, circles, etc.). The composite planar structures are represented by a special class of graphs where the nodes satisfy a two-dimensional ordering. We use straightforward algorithms to generate these graphs from an image (obtained using a vision system) that was preprocessed by a system of low-level neural networks. The graphs are generated for all arrangements of elementary objects in an image, and the resulting graphs are compared with predetermined models of composite objects in order to determine if the composite object is present in the image. We present an algorithm to find out if two given graphs match within a specified tolerance given by the pair (l,d). We then develop a similarity measure between two graphs based on two different linearizations of two-dimensional lattice points. A decision making module, based on empirical rules, decides if the image contains any instances of the prestored models of composite objects. 10 refs., 4 figs.

29885 (CONF-9006167–1) **Hypersingular integrals and the two dimensional Helmholtz equation.** Gray, L.J. Oak Ridge National Lab., TN (USA). [1990]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Japan/USA symposium; Palo Alto, CA (USA); 5-7 Jun 1990. Order Number DE90009821. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Hypersingular integral equations have proven to be very effective tool in the boundary element analysis of regions containing cracks. In previous studies, the reduction of the singular terms to a computationally reasonable form has relied on the the ability to analytically integrate the Green's function over a flat element. The purpose of this paper is to investigate the integration of a more complicated fundamental solution, that of the two dimensional Helmholtz equation, over a curved element. The Hankel functions are treated by integrating the singular part analytically, and other Green's functions. However, the higher dimensional analogue of the procedure employed herein to treat the quadratic isoparametric element is not practical, and other techniques will be required. 19 refs., 2 figs.

29886 (CTA-IEAv-NT–006/89) **Improvements in the BCG code.** Leite, S.B. (Jaakko Polyry Engenharia, Sao Paulo, SP (Brazil)); Caldeira, A.D.; Garcia, R.D.M. Centro Tecnico Aeroespacial, Sao Jose dos Campos, SP (Brazil). Inst. de Estudos Avancados. Sep 1989. 14p. Order Number DE90625245. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Some improvements introduced in the BCG code with the objective of making the code faster in execution are reported. The impact of these improvements in terms of CPU time saving is discussed for a sample problem. (author).

29887 (CTA-IEAv-NT–013/89) **BIBGTR: nuclear data libraries for the programs Unimug and Anisn.** Ono, S.; Caldeira, A.D. Centro Tecnico Aeroespacial, Sao Jose dos Campos, SP (Brazil). Inst. de Estudos Avancados. Nov 1989. 9p. (In Portuguese). Order Number DE90625246. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

Nuclear data libraries generable by the NJOY for the programs UNIMUG and ANISN, using evaluated data from ENDF/B-IV and ENDF/B-V are described. These libraries will be used by Radioisotope Thermoelectric Generators Project of Instituto de Estudos Avancados. (author).

29888 (CTA-IEAv-NT–015/89) **Preliminary tests of WIMSD/4 program installed in a CDC CYBER 170/750 at IEAV.** Claro, L.H.; Anaf, J. Centro Tecnico Aeroespacial, Sao Jose dos Campos, SP (Brazil). Inst. de Estudos Avancados. Dec 1989. 17p. (In Portuguese). Order Number DE90625247. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Some cell calculations options of the WIMSD/4 code were tested. Comparisons with the HAMMER code results are presented. Control cards for WIMSD/4 execution in the IEAv CDC CYBER 170/750 and input examples are included. (author).

29889 (CTA-IEAv-RI–015/89) **Adaptation of the SAR program to 89-1 version of the programs LINEAR, RECENT and SIGMA 1.** Caldeira, A.D.; Garcia, R.D.M. Centro Tecnico Aeroespacial, Sao Jose dos Campos, SP (Brazil). Inst. de Estudos Avancados. Oct 1989. 7p. (In Portuguese). Order Number DE90625248. Available from NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS.

The new subroutine Readpr of program Sar, compatible with the 89-1 version of programs Linear, Recent and Sigma 1 is presented.

29890 (DOE/ER/25054–2) **A broad research program on the sciences of complexity: Annual report.** Santa Fe Inst., NM (USA). 26 Jan 1990. 176p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER25054. Order Number DE90009625. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

The second full-fledged academic year at the Santa Fe Institute saw it extend its research activities centered on its organizing principle: complex systems. While there is not generally accepted definition of a complex system, common properties appear in the behavior of such systems. Complex systems typically have many components which interact nonlinearly. They frequently exhibit collective and emergent properties such as adaptation, pattern formation, and learning. There is often a hierarchy of length or time

scales, and sensitivity to initial conditions. Dissipative time evolution is characteristic; the system may be open to an environment that presents it with perpetual challenge; it may operate far from equilibrium and have a stochastic aspect. Typically there are many differing modes of behavior (solutions) of varying likelihood, as exemplified in evolutionary biology, turbulent flows, or glasses. Many complex systems have information storage capacity or memory and some are capable of extrapolating stored information to anticipate the future. At the beginning of 1989 many of the SFI research initiatives described in this report were already well established. Preliminary workshops had been held, in some cases subsequent full workshops were planned or had been held, collaborations were well established, and a residential research program was underway.

29891 (EGG-CATT–8898) **FORTRAN coding guidelines.** Cook, D.M.; Marshall, N.H.; Marwil, E.S.; Matthews, S.D.; Mortensen, G.A. EG and G Idaho, Inc., Idaho Falls, ID (USA). Computer Applications and Technology Transfer Group. Feb 1990. 13p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009804. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes the FORTRAN coding guidelines used by the Scientific Computing Unit at EG&G Idaho, Inc. All new software development of FORTRAN codes employs these guidelines. Existing software which undergoes adaptive or perfective maintenance is upgraded to meet these guidelines whenever possible. These guidelines are based on adherence to the FORTRAN language standard and utilization of good programming practices to achieve consistency within each software project. 7 refs.

29892 (EGG-CATT–8926) **VCS: A networked version control system.** Barber, D.G. EG and G Idaho, Inc., Idaho Falls, ID (USA). Computer Applications and Technology Transfer Group. Feb 1990. 26p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE90009805. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Version Control System (VCS) is a portable source control system which is based on the generic Source Code Control System (sccs) provided with many Unix systems. It extends the sccs capabilities and provides support for networked application development. The networking support is provided through TCP/IP facilities. VCS includes functions for version control, change control, base-lining and status reporting. Audit trail, project management, and application development tools are also provided.

29893 (JAERI-M–89-190) **Current status of uncertainty analysis methods for computer models.** Ishigami, Tsutomu (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1989. 70p. Order Number DE90777717. Available from NTIS (US Sales Only), PC A04/MF A01.

This report surveys several existing uncertainty analysis methods for estimating computer output uncertainty caused by input uncertainties, illustrating application examples of those methods to three computer models, MARCH/CORRAL II, TERFOC and SPARC. Merits and limitations of the methods are assessed in the application, and recommendation for selecting uncertainty analysis methods is provided. (author).

29894 (KEK–89-3) **Proceedings of the symposium on networking.** Karita, Yukio; Abe, Fumio (eds.). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jun 1989. 306p. (CONF-8902176–: 1. symposium on networking, Tsukuba (Japan), 6-7 Feb 1989). Order Number DE90777889. Available from NTIS (US Sales Only), PC A14/MF A01.

The first symposium on networking was held on February 6-7, 1989. Due to the increase of the needs of computer networks, several networks which connect among universities and laboratories are going to be constructed in Japan. However, the techniques in networking are not familiar to most people, and the information about these techniques is sometimes difficult to get, especially in multivendor connection. In such situation, an opportunity to hold a symposium on networking at the National Laboratory for High Energy Physics (KEK) was given. More than 200 people took part in this symposium, and the local area networks in institutions, the networks among institutions, the networks for high energy physics, the application of networks, the networks for academic research and so on are reported. The valuable discussion about networks was carried out, including the plans for near future. At the time of this symposium, the construction of the Gakujo-net and the Pacific network project of University of Hawaii were in progress, and many Japanese universities are going to construct their campus LANs, so the symposium seemed to be very timely. (K.I.).

29895 (OPTIMITURVE–7) **Knowledge based production planning for milled peat production.** Huusko, A. (Oulu Univ. (Finland). Research Inst. of Northern Finland). Valtion Teknillinen Tutkimuskeskus, Jyvaeskylae (Finland). Polttoaine- ja Polttotekniikan Lab. 1989. 24p. (In Finnish). Order Number DE90770715. Available from NTIS (US Sales Only), PC A03/MF A01.

In this report the observations of accomplishment and construction of knowledge-based peat production control system applicable for Haku peat production methods have been described. A hierarchical solution of the problem has been described. The estimation of factors like production risks and planning targets may be fulfilled by using method resembling expert system based on heuristics. On the lower hierarchical levels, e.g. in dividing of resources and in scheduling, the superiority of the logical programming is negligible.

29896 (PB–90-153354/XAB) **Parallel nonlinear optimization.** Lootsma, F.A. Technische Hogeschool Delft (Netherlands). Dept. of Mathematics and Informatics Computer Science. c 1989. 40p. (REPT–89-45). Available from NTIS, PC A03/MF A01.

The survey is concerned with three classes of nonlinear optimization methods which are highly suitable for implementation on parallel computers. In the area of unconstrained optimization, it concentrates on the Newton and quasi-Newton methods, because they can readily be converted into synchronous or asynchronous algorithms. Promising classes of methods in the area of constrained minimization are the so-called dual algorithms for separable and partially separable problems, and the decomposition techniques for block-angular problems with a small number of linking variables or linking constraints. Numerical experience with parallel implementations is limited in each of these classes of methods, but their potential has been widely explored on sequential computers. Accordingly, the paper sketches the possible benefits of parallel computering in the field of nonlinear optimization.

29897 (PB–90-154337/XAB) **Generally configurable multigrid implementation for transputer networks.** El-Giar, O.; Hopkins, T. Kent Univ., Canterbury (UK). Computing Lab. c Jun 1989. 16p. (UKC/COMPUTING LAB–63). Available from NTIS, PC EE04/MF E04.

The paper describes the performance of a multigrid method implemented on a transputer-based architecture. The authors show that the combination of fast floating-point hardware, local memory and fast communication links between processor provide an excellent environment for the parallel implementation of multigrid algorithms. The gain in efficiency obtained by increasing the number of processors is shown to be nearly linear and comparisons are made with published figures for a parallel multigrid Poisson solver on an Intel iPSC 32-node hypercube.

29898 (PB–90-154436/XAB) **Distributed ray tracing using an SIMD (single instruction multiple data) processor array.** Williams, N.S.; Buxton, B.F.; Buxton, H. British Petroleum Co. Ltd., Sunbury-on-Thames (UK). BP Research Centre. 1990. 24p. Available from NTIS, PC EE04/MF E04.

Recent work on distributed ray tracing algorithms using the Distributed Array Processor (DAP) will be described. It is shown that ray tracing algorithms are ideally suited to SIMD processor arrays because, once a set of rays has been cast from the viewpoint through pixels in the image plane, the origin and direction vectors which parameterize each ray from successive reflections can be mapped uniformly to the DAP processor array. Using an SIMD processor array in conjunction with the parallel algorithms presented, highly realistic graphics images can be produced in very short runtimes.

29899 (PB–90-154451/XAB) **Parallel matching and reconstruction algorithms in computer vision.** Kashko, A.; Buxton, B.; Castelow, D.A.; Buxton, H. Queen Mary Coll., London (UK). Dept. of Computer Science. 1987. 49p. Available from NTIS, PC EE05/MF E05.

Parallel implementations of a number of computer vision algorithms for visual reconstruction and matching are described. The algorithms chosen range in complexity from those requiring only image correlation and other simple operations to more sophisticated iterative algorithms involving relaxation, simulated annealing and graduated non-convexity. In each case the algorithms are implemented in parallel by mapping the images directly onto an SIMD processor array. Brief descriptions of the algorithms are given together with sample results and timings for their implementation on a 64 x 64 ICL DAP.

29900 (PB–90-155144/XAB) **Parallel approach for solving stiff systems of ODE's.** Khaddaj, S. Queen Mary Coll., London (UK). Dept. of Computer Science. 1990. 9p. Available from NTIS, PC EE04/MF E04.

The paper is concerned with the problem of speeding up the numerical solution of stiff systems of ordinary differential equations by parallel computations. The study focuses on parallelizing the solution of algebraic systems which arise at each step of the integration by standard implicit methods. An implementation of column-oriented Gauss-Jordan elimination on a multiprocessor machine is presented. Codes based on this approach are written in occam for solving different problems. Test results on the Meiko Computer Surface are reported.

29901 (PB–90-155227/XAB) **SIMD parallel version of the GLS optic flow algorithm.** Kashko, A. Queen Mary Coll., London (UK). Dept. of Computer Science and Statistics. 1987. 43p. Available from NTIS, PC EE05/MF E05.

A parallel version of Scott's optic flow algorithm on an SIMD architecture is described. Since the algorithm involves identical calculations at each pixel, there is a high degree of image parallelism which is exploited by the parallel program. Results obtained by running the algorithm on a test image of real data are presented, and the convergence of the algorithm is considered.

29902 (PB–90-157207/XAB) **Parallel relaxation labelling for optic flow.** Kashko, A. Queen Mary Coll., London (UK). Dept. of Computer Science and Statistics. 1989. 56p. Available from NTIS, PC EE06/MF E06.

Single Instruction Multiple Data (SIMD) parallel implementations of the classical relaxation labelling algorithm of Rosenfield and Kak, and the symmetrized algorithm of Ibison and Zapalowski for estimating optic flow are described and the performances of the two algorithms on a random dot kinematogram are compared.

29903 (PB–90-159823/XAB) **Federal High-Performance Computing program.** Office of Science and Technology Policy, Washington, DC (USA). 8 Sep 1989. 89p. Available from NTIS, PC A05/MF A01.

High-Performance Computing is a pervasive and powerful technology for industrial design and manufacturing, scientific research, communications, and information management. Its goals are to maintain and extend U.S. leadership in high-performance computing, and encourage U.S. sources of production; encourage the pace of innovation in high-performance computing technologies by increasing their diffusion and assimilation into the U.S. science and engineering communities; and support U.S. economic competitiveness and productivity through greater utilization of networked high performance computing in analysis, design, and manufacturing.

29904 (PB–90-168303/XAB) **Concurrent constructive logic. Technical report series.** Holt, C.M. Newcastle upon Tyne Univ. (UK). Computing Lab. c Apr 1988. 21p. (NTU-CL/TRS–255). Available from NTIS, PC EE03/MF E03.

A constructive logic may be viewed as a means for applying the operations of logic to the general domain of values used in functional application, combining data and control structures. It is an algebra over a domain that has been partitioned into logical subdomains, e.g. T (true), U (undecided), and F (false). Pure logical functions respect the partitioning by mapping subdomains into subdomains; they satisfy truth tables. Quasi-logical functions satisfy truth tables except for specific classes of values; non-standard implication and equality are introduced as examples. Communication in a time-free expression is considered, in which the use of a name in one position is related by a logical function to its use in another position. Although it is possible to embed this kind of relation in the text of an expression, in many cases it is simpler to use a directed reference graph from uses to referents, in which each arc is associated with a logical value indicating whether or not that path is used in the determination of the value of the name. Time sequences are introduced using this as a basis, and communication among concurrent processes follows naturally.

29905 (PB–90-861063/XAB) **Multiple instruction-multiple data stream (MIMD) computer architecture. January 1977-January 1990 (A Bibliography from the INSPEC: Information Services for the Physics and Engineering Communities data base). Report for January 1977-January 1990.** National Technical Information Service, Springfield, VA (USA). Feb 1990. 124p. Available from NTISPC N01/MF N01.

Supersedes PB–87-863007.

This bibliography contains citations concerning the design, development, and applications of multiple instruction, multiple data stream (MIMD) computers and computer architecture. Design aspects, parallel processing, and language considerations are among the topics discussed. MIMD interconnection network design, implementation, and analysis are included. Some attention is given to specific systems descriptions. (This updated bibliography contains 216 citations, 92 of which are new entries to the previous edition.)

29906 (PNL–7301) **Looking at large data sets using binned data plots.** Carr, D.B. Pacific Northwest Lab., Richland, WA (USA). Apr 1990. 52p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. Order Number DE90008206. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This report addresses the monumental challenge of developing exploratory analysis methods for large data sets. The goals of the report are to increase awareness of large data sets problems and to contribute simple graphical methods that address some of the problems. The graphical methods focus on two- and three-dimensional data and common task such as finding outliers and tail structure, assessing central structure and comparing central structures. The methods handle large sample size problems through binning, incorporate information from statistical models and adapt image processing algorithms. Examples demonstrate the application of methods to a variety of publicly available large data sets. The most novel application addresses the"too many plots to examine" problem by using cognostics, computer guiding diagnostics, to prioritize plots. The particular application prioritizes views of computational fluid dynamics solution sets on the fly. That is, as each time step of a solution set is generated on a parallel processor the cognostics algorithms assess virtual plots based on the previous time step. Work in such areas is in its infancy and the examples suggest numerous challenges that remain. 35 refs., 15 figs.

29907 (RCNP-P–104) **Collection of reports on use of computation fund utilized in common in 1988.** Osaka Univ., Ibaraki (Japan). Research Center for Nuclear Physics. May 1989. 157p. (In Japanese). Order Number DE90777885. Available from NTIS (US Sales Only), PC A08/MF A01.

Nuclear Physics Research Center, Osaka University, has provided the computation fund utilized in common since 1976 for supporting the computation related to the activities of the Center. When this computation fund is used, after finishing the use, the simple report of definite form (printed in RCNP-Z together with the report of the committee on computation fund utilized in common) and the detailed report concerning the contents of computation are to be presented. In the latter report, English abstract, explanation of the results obtained by computation and physical contents, new development, difficult point and the method of its solution in computation techniques, subroutine and function used for computation and their functions and block diagrams and so on are included. This book is the collection of the latter reports on the use of the

computation fund utilized in common in fiscal year 1988. The invitation to the computation fund utilized in common is informed in December every year in RCNP-Z. (K.I.).

29908 (SAND–89-2244C) **Spline function smoothing and differentiation of noisy data on a rectangular grid.** Dohrmann, C.R (Sandia National Labs., Albuquerque, NM (USA)); Busby, H.R. Sandia National Labs., Albuquerque, NM (USA). [1990]. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9006124–2: Society for Experimental Mechanics conference, Albuquerque, NM (USA), 4-6 Jun 1990). Order Number DE90009319. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A method is presented for smoothing and differentiating noisy data given on a rectangular grid. The method makes use of a one-dimensional smoothing algorithm to construct the solution to an associated two-dimensional problem. Smoothing parameter selection is automated using a technique that does not require prior knowledge of the amount of noise in the data. Numerical examples are provided demonstrating the application of the method. 4 refs., 8 figs., 2 tabs.

29909 (SAND–89-2383C) **An acousto-optic image correlator with a throughput rate of 1000 templates per second.** Molley, P.A. Sandia National Labs., Albuquerque, NM (USA). 28 Mar 1990. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-9004125–3: 8. SPIE's applications of artificial intelligence conference, Orlando, FL (USA), 17-19 Apr 1990). Order Number DE90009323. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A two dimensional image correlator based on acousto-optic (AO) and charge-coupled devices (CCDs) is described that can be built with existing technology to provide 1000 frames per second operation. In recent years, architectures have been developed that perform the two dimensional correlation utilizing one dimensional input devices. The input scene is loaded into the acousto-optic device (AOD) one line at time. This line is then correlated against all of the rows of a reference template introduced into the optical system using a one dimensional array of LEDs or laser diodes. However, it generally takes a much greater time to load the AO cell than it does to process the information. this latency time severely limits the maximum throughput rate of the processor. This paper introduces a new acousto-optic correlator implementation that overcomes this bottleneck so that processing can occur close to 100% of the time. A grayscale image correlator is proposed that can be built using present technology that can realistically achieve throughput rates on the order of 10^{12} operations per second. This translates to over 1000 correlations per second for input scenes with dimensions of 512 x 512 pixels and reference templates of size 64 x 64 pixels. 10 refs., 4 figs.

29910 (SAND–90-0249) **Paving: A new approach to automated quadrilateral mesh generation.** Blacker, T.D. (Sandia National Labs., Albuquerque, NM (USA)); Stephenson, M.B. Sandia National Labs., Albuquerque, NM (USA). Mar 1990. 56p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE90010244. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This paper presents a new mesh generation technique, paving, which meshes arbitrary 2-D geometries with an all-quadrilateral mesh. Paving allows varying element size distributions on the boundary as well as the interior of a region. The generated mesh is well formed (i.e., nearly square elements, elements perpendicular to boundaries, etc.) and geometrically pleasing (i.e., mesh contours tend to follow geometric contours of the boundary). In this paper we describe the theory behind this algorithmic/heuristic technique, evaluate the performance of the approach, and present examples of automatically generated meshes. 17 refs., 42 figs.

29911 (SOL–90-5) **A generalized complementarity problem in Hilbert space.** Yao, Jen-Chih. Stanford Univ., CA (USA). Systems Optimization Lab. Mar 1990. 5p. Sponsored by U.S. Department of Defense; U.S. DOE Energy Research; National Science Foundation. DOE Contract FG03-87ER25028. Order Number DE90009576. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An existence theorem for a generalized complementarity problem over arbitrary closed convex cone in a Hilbert space is proved.

29912 (UCRL–52000-90-1/2) **Energy and Technology Review, January–February 1990.** Burnham, A.K.; Cabral, B.K. (eds.). Lawrence Livermore National Lab., CA (USA). [1990]. 62p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90010155. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This issue of Energy and Technology Review describes a number of the Laboratory's efforts and achievements in computerized scientific visualization. Each article describes a different visualization software and hardware system. The systems all share the common goal of relaying complex numerical information to scientists in a readily comprehensible form. They differ in two significant ways — how they render or generate the images, and the operational environment in which they function. The image-rendering technique chosen is usually determined by the desired quality, type, and cost of the images. The operating environment (e.g., the speed with which images must be generated, whether they are used locally or must be sent to remote locations) governs the level of image detail, the range of colors used, and other such characteristics. These constraints greatly influence the overall design of a visualization system. 49 figs.

29913 (UCRL–102052) **Using object-oriented analysis techniques to support system testing.** Zucconi, L. Lawrence Livermore National Lab., CA (USA). Mar 1990. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9006164–1: 7. international conference on testing computer software, San Francisco, CA (USA), 21 Jun 1990). Order Number DE90009540. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Testing of real-time control systems can be greatly facilitated by use of object-oriented and structured analysis modeling techniques. This report describes a project where behavior, process and information models built for a real-time control system were used to augment and aid traditional system testing. The modeling techniques used were an adaptation of the Ward/Mellor method for real-time systems analysis and design [Ward85] for object-oriented development. The models were used to simulate system behavior by means of hand execution of the behavior or state model and the associated process (data and control flow) and information (data) models. The information model, which uses an extended entity-relationship modeling technique, is used to identify application domain objects and their attributes (instance variables). The behavioral model uses state-transition diagrams to describe the state-dependent behavior of the object. The process model uses a transformation schema to describe the operations performed on or by the object. Together, these models provide a means of analyzing and specifying a system in terms of the static and dynamic properties of the objects which it manipulates. The various models were used to simultaneously capture knowledge about both the objects in the application domain and the system implementation. Models were constructed, verified against the software as-built and validated through informal reviews with the developer. These models were then hand-executed. 6 refs.

29914 (UCRL–102263-Rev.1) **SISAL 1.2: An alternative to FORTRAN for shared memory multiprocessors.** Cann, D.; Feo, J. Lawrence Livermore National Lab., CA (USA). 20 Nov 1989. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-9006101–1-Rev.1: ACM SIGPLAN '90: conference on programming language design and implementation, White Plains, NY (USA), 20 Jun 1990). Order Number DE90005181. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The acquisition of parallel processors in the scientific community is increasing, but the difficulties of programming parallel machines persist. Two approaches have emerged: automatic parallelizing compilers for extant languages, and new languages that provide an easier-to-use and cleaner parallel programming model. Unfortunately most new languages have acquired a reputation for inefficiency because of their semantics. This paper compares the performance of SISAL 1.2, an applicative language for parallel numerical computations, and FORTRAN using the Livermore Loops.

We show that applicative programs when compiled using a set of powerful yet simple optimization techniques can achieve execution speeds comparable to FORTRAN, and can effectively exploit shared memory multiprocessors. 16 refs., 2 figs., 2 tabs.

29915 (UCRL–102872) **Coping with nonuniform Unix interfaces in designing a portable network driver.** Wolski, R. Lawrence Livermore National Lab., CA (USA). [1990]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9006123–1: USENIX conference proceedings, Anaheim, CA (USA), 11-18 Jun 1990). Order Number DE90007651. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The need for portable software continues to increase, especially within the Unix community, where a uniform interface is assumed to exist. Unfortunately, system software (particularly that which executes as part of the kernel) often has not been written to take full advantage of the homogeneity offered by Unix. Further, there is a need even within the kernel for greater uniformity of interfaces. This paper describes some of the issues associated with the design and implementation of a kernel-level protocol driver which is portable among various Unix implementations. It also recommends areas where interfaces could be more uniform across implementations. 15 refs.

29916 (UCRL-JC–103143) **Implementing TCP/IP and a socket interface as a server in a message-passing operating system.** Hipp, E.; Wittzius, D. Lawrence Livermore National Lab., CA (USA). Mar 1990. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-9004179–1: Cray users group conference, Toronto (Canada), Apr 1990). Order Number DE90009920. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The UNICOS 4.3BSD network code and socket transport interface are the basis of an explicit network server for NLTSS, a message passing operating system on the Cray YMP. A BSD socket user library provides access to the network server using an RPC mechanism. The advantages of this server methodology are its modularity and extensibility to migrate to future protocol suites (e.g. OSI) and transport interfaces. In addition, the network server is implemented in an explicit multi-tasking environment to take advantage of the Cray YMP multi-processor platform. 19 refs., 5 figs.

29917 (UCRL-MA–103419) **SPI/VMS installation guide.** King, M.E. Lawrence Livermore National Lab., CA (USA). 12 Mar 1990. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE90009955. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This document provides information on how to install SPI/VMS. This product runs on VMS Version 5.1 and above. The SPI.BCK saveset contains all the files necessary to run and compile SPI/VMS. This document assumes that you have a copy of the saveset on a magnetic tape or in a directory on a Files-11 disk.

29918 Optical recognition of 3-D targets. Schils, G.F. (Sandia National Labs., Livermore, CA (USA)); Ochoa, E. pp. 257 of Real-time signal processing for industrial applications. Javidi, B. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). (CONF-8806355–: Real time signal processing for industrial applications, Dearborn, MI (USA), 27-28 Jun 1988).

A method of pattern recognition is presented that can recognize image variations such as different perspective views of a three-dimensional object. The general theory allows many different kinds of image variations, such as rotation, scale. perspective, or combinations of these, to be recognized. The method produces a small bank of about 20 filters to be used in a correlator. The authors call these filters lock-and-tumbler filters. The theory is illustrated on several different kinds of invariant pattern recognition problems. The correlation filters designed for these invariant recognition problems may be modified to reject certain kinds of clutter in an input scene. An example of modifying these filters to achieve rejection of clutter is given. An implementation of the lock-and-tumbler filter method using a high speed digital correlator is described.

29919 Basis: Setting the scientist free. Dubois, P.F. (Lawrence Livermore National Lab., CA (USA)). pp. 180 of Proceedings of the 1989 IEEE International conference on plasma science (Abstracts). IEEE Service Center, Piscataway, NJ (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8905184–: Institute of Electrical and Electronics Engineers international conference on plasma science, Buffalo, NY (USA), 22-24 May 1989).

The author presents Basis, a program development system for scientific programs. It is available on Cray machines and Sun workstations, with other environments to follow. The Basis System includes two major components, a program development system and a run-time package. The run-time package provides the Basis language interpreter, through which the user does input, output, plotting, and controls the program's subroutines and functions. Variables in the scientific packages are known to this interpreter, so that the user may arbitrarily print, plot, and calculate with, any major program variables. Also provided are facilities for dynamic memory management, terminal logs, error recovery, text-file i/o, and the attachment of non-Basis-developed packages.

29920 Systolic implementation of neural networks. DeGroot, A.J. (Lawrence Livermore National Lab., Livermore, CA (USA)). pp. 261 of High speed computing II. Bromley, K. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1989). DOE Contract W-7405-ENG-48. (CONF-8901150–: 2. high speed computing, Los Angeles, CA (USA), 17-18 Jan 1989).

The backpropagation algorithm for error gradient calculations in multilayer, feed-forward neural networks is derived in matrix form involving inner and outer products. It is demonstrated that these calculations can be carried out efficiently using systolic processing techniques, particularly using the SPRINT, a 64-element systolic processor developed at Lawrence Livermore National Laboratory. This machine contains one million synapses, and forward-propagates 12 million connections per second, using 100 watts of power. When executing the algorithm, each SPRINT processor performs useful work 97% of the time. The theory and applications are confirmed by some nontrivial examples involving seismic signals recognition.

29921 A pnpn optical switch. Pankove, J.I. (Colorado Univ., Boulder, CO (USA). Dept. of Computer Science); Hayes, R.; Majefeld, A.; Hannaa, M.; Oh, E.G.; Szmyd, D.M.; Suda, D.; Asher, S.; Matson, R. pp. 732 of Optical computing 88. Goodman, J.W.; Chavel, P.; Roblin, G. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (USA) (1988). (CONF-8808221–: Optical computing '88, Toulon (France), 29 Aug - 2 sep 1988).

The pnpn optical switch is an optoelectronic device that emits light in response to an optical input while an electrical bias is applied. A clocked bias insures synchronization. Other modes of operation are possible. The authors report pnpn structures fabricated by different techniques. Turn-on and turn-off times of less than 10 nsec have been obtained. High optical gain is possible. Some logic functions can be accomplished within this threshold device.

29922 Partitioning programs for parallel execution. Girkar, M. (Illinois Univ., Urbana, IL (USA). Center for Supercomputing Research and Development); Polychronopoulos, C. pp. 687 of 1988 international conference on supercomputing. Association for Computing Machinery, New York, NY (USA) (1988). (CONF-8807116–: International conference on supercomputing, Saint-Malo (France), 4-8 Jul 1988).

The ability of parallel computers to execute multiple instruction streams (tasks) simultaneously gives rise to the problem of partitioning a program into a set of tasks that can be assigned to different processors.The degree to which parallelism can be exploited, the amount of overhead involved during parallel execution of a program and a number of other factors depend directly on partitioning. A good partitioning scheme must take into account all these factors. In this paper, the authors present algorithms to compute partitions in diverse models of the problem. Both directed and undirected graph representations of a parallel program are considered. For some instances of the problem where practical optimal schemes are not possible, the authors suggest simple and efficient heuristics. Finally, a polynomial time algorithm to compute optimal partitions for chains is given.

29923 Hierarchical registers for scientific computers. Swensen, J.A. (California Univ., Berkeley, CA (USA)). pp. 687 of 1988 international conference on supercomputing. Association for Computing Machinery, New York, NY (USA) (1988). (CONF-8807116–: International conference on supercomputing, Saint-Malo (France), 4-8 Jul 1988).

Simulations of scientific programs running on traditional scientific computer architectures show that execution with hundreds of registers can be more than twice as fast as execution with only eight registers. In addition, execution with a small number of fast registers and hundreds of slower registers can be as fast as execution with hundreds of fast registers. A hierarchical organization of fast and slow registers is presented, register-allocation strategies are discussed, and an indirect, register-addressing mechanism is described.

29924 Performance of a shared memory system for vector multiprocessors. Turner, S.W. (Univ. of Illinois (US)); Veidenbaum, A.V. pp. 687 of 1988 international conference on supercomputing. Association for Computing Machinery, New York, NY (USA) (1988). MIP8414-10110. (CONF-8807116–: International conference on supercomputing, Saint-Malo (France), 4-8 Jul 1988).

In this paper the authors present results showing the behavior of not only a MIN but of an entire shared memory system obtained through simulation. They attempts to evaluate the performance and interaction between components of such a system, based on realistic hardware assumptions and driven by user programs. To achieve this they have developed a parallel register-transfer level simulator of interconnection networks and an interleaved shared memory. The simulator itself runs on a multiprocessor (Alliant FX/8). The authors study non-uniform, burst traffic as exhibited by prefetch or vector units in each processor. Because the exact behavior of the hardware is simulated, they also obtain a time dependent description of system performance. In the first part of this paper the authors describe the system being studied. They define the metrics used to evaluate the performance of the system. The benchmarks used in this evaluation are then discussed. The results of the experiment are presented, and conclusions drawn. Attached appendices contain listings of the kernels used, as well as a table summarizing the exact values of performance measures presented.

29925 Impact of self-scheduling order on performance of multiprocessor systems. Tang, P. (Illinois Univ., Urbana, IL (USA). Center for Supercomputing Research and Development); Yew, P.C.; Qizhu, C. pp. 687 of 1988 international conference on supercomputing. Association for Computing Machinery, New York, NY (USA) (1988). (CONF-8807116–: International conference on supercomputing, Saint-Malo (France), 4-8 Jul 1988).

Processor self-scheduling is an efficient dynamic scheduling for multiprocessors. This paper discusses the impact of the self-scheduling order on the performance of multiply-nested parallel loops. It is shown that, due to data synchronization for cross-iteration data dependences, the completion time of a multiply-nested loop is reduced when the nesting parallel loops with smaller delays are moved to the inside. The best performance is achieved when a shortest-delay scheduling order is used. The performance of the shortest-delay self-scheduling is compared to other self-scheduling orders and to compile-time static scheduling order proposed elsewhere. Program transformation needed to implement shortest-delay self-scheduling is also included.

29926 A benchmark package for sparse matrix computations. Saad, Y. (Illinois Univ., Urbana, IL (USA). Center for Supercomputing Research and Development); Wijshoff, A.G.H. pp. 687 of 1988 international conference on supercomputing. Association for Computing Machinery, New York, NY (USA) (1988). (CONF-8807116–: International conference on supercomputing, Saint-Malo (France), 4-8 Jul 1988).

The authors examine the problem of evaluating performance of supercomputer architectures on sparse (matrix) computations and lay out the details of a benchmark package for this problem. Whereas there already exists a number of benchmark packages for scientific computations, such as the Livermore Loops, the Linpack benchmark and the Los Alamos benchmark, none of these deals with the specific nature of sparse computations. Sparse matrix techniques are characterized by the relatively small number of operations per data element and the irregularity of the computation. Both facts may significantly increase the overhead time due to memory traffic. For this reason, the performance evaluation of sparse computations should not only take into account the CPU performance but also the degradation of performance caused by high memory traffic. Furthermore, sparse matrix techniques comprise a variety of different types of basic computations. Taking these considerations into account they propose a benchmark package that consists of several independent modules, each of which has a distinct role.

29927 The design and evaluation of a front-end user interface for energy researchers. Borgman, C.L. (Univ. of California, Los Angeles (USA)); Case, D.O.; Meadow, C.T. *Journal of the American Society for Information Science (USA)*, 40(2): 99-109 (Mar 1989).

The report covers a two-year project to develop a set of microcomputer-based training and assistance programs to support end user access to the Energy Database on the Department of Energy information retrieval systems. A set of programs were designed and tailored to the information needs, skills and information-seeking habits of energy researchers. Discussion covers the issues in development, evaluation and study of user behavior in designing an interface tailored to a special population. Some background information is provided on information systems and database use. 32 refs.

29928 Online access to knowledge: System design. Meadow, C.T. (Univ. of Toronto, Ontario (Canada)); Cerny, B.A.; Borgman, C.L., Case, D.O. *Journal of the American Society for Information Science (USA)*, 40(2): 86-98 (Mar 1989). DOE Contract AC05-80OR11232.

The project Online Access to Knowledge (OAK) has developed a computer intermediary for selected users of the Department of Energy's (DOE) online information retrieval systems. Its purpose is to enable people who have little or no training or experience in bibliographic searching to conduct their own searches, without the assistance of a trained librarian. This permits the user to work in both a place and time of their choosing. This report discusses the design and rationale for the system. OAK software consists of both a tutorial and an assistance program. A command language is not used, which obviates the need for a searcher to learn a formal query language. 20 refs.

29929 Error analysis for parameters determined in nonlinear least-squares fits. Burrell, K.H. (General Atomics, San Diego, California 92138 (US)). *American Journal of Physics (USA)*, 58(2): 160-164 (Feb 1990). DOE Contract AC03-84ER51044.

This article presents a calculation of the error in parameters derived from the least-squares method of fitting nonlinear models to experimental data. The formula reduces to the well-known result for the case of a linear least-squares fit. It differs, however, from a method for calculating the error that is often employed for the nonlinear case. The difference between the current result and that method's is illustrated with examples from least-squares fits to spectroscopic data.

9903 Information Handling

Refer also to citation(s) 27722, 27758, 28117, 28192, 28878, 29444, 29853, 29865, 29866, 29867, 29868, 29869, 29870, 29871, 29872, 29873, 29874, 29875, 29876, 29877, 29878, 29879, 29880, 29881, 29882, 29883, 29890, 29912, 29927, 29928

29930 (ANL/EAIS/TM–7) **Records management modernization study.** Kadec, S.; Hill, L.G.; Riemer, C.A. Argonne National Lab., IL (USA). Environmental Assessment and Information Sciences Div. Dec 1989. 95p. Sponsored by Veterans Administration. DOE Contract W-31109-ENG-38. Order Number DE90009372. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The Department of Veterans Affairs (VA) has a single purpose or mission: to provide benefits to the veterans of the nation. Most of these benefits are provided through its medical and health facilities located around the country: the hospitals, nursing homes, and clinics that give medical examinations and provide long-term care or

hospitalization. A second sizeable program managed by the Veterans Benefit Administration (VBA) gives pensions, benefits for disability and education, insurance, and home loans to those veterans eligible under law and specific service conditions. In support of the benefits programs, VA staff in the regional offices (ROs) receive and create a large amount of documentation. This documentation supports the award or disallowance of benefits by providing the information necessary to determine eligibility and the amount of the award. This paperwork, which is necessary to document actions and support the appeals process, creates a huge record-keeping problem for the ROs. 6 tabs.

29931 (DOE/DP/70033–4-Vol.1) **Research and development of models and instruments to define, measure, and improve shared information processing within government oversight agencies: Volume 1, 4th annual performance report: research status, August 1989–July 1990.** Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (USA). Management Systems Labs. [1990]. 196p. Sponsored by U.S. DOE Defense Programs. DOE Contract FG05-86DP70033. Order Number DE90009989. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

Plans to study is at the very forefront of information systems and management research. The first phase of the research objective is exploratory. Exploratory research is longitudinal. During this phase of research, we form objectives, construct qualitative models, emphasize defining relationships and comparisons, make observations to draw implications, corroborate findings, and define directions. The second and third phases are confirmatory. Confirmatory research is cross-sectional. Through confirmatory research we form hypotheses, construct quantitative models, emphasize measurement and evaluation, set up and run experiments, verify results, and draw conclusions. This annual performance report describes the previous years' research efforts and the plan for the upcoming year.

29932 (ORNL/TM–11534) **Subject bibliography of the PMA205 [Program Manager Air 205] Network Technical Library at Oak Ridge National Laboratory.** Ayers, M.V. Oak Ridge National Lab., TN (USA). 1 May 1990. 109p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE90009988. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The PMA205 (Program Manager Air 205) Network Technical Library at the Oak Ridge National Laboratory (ORNL) contains documents relating to US Department of Defense standards for computer-based training technology and training and American National Standards Institute international standards for user interfaces and Computer-Aided Acquisition and Logistic Support. The collection emphasizes supporting research in instructional system design, software engineering, user system interfaces, human factors engineering, and cognitive psychology as it differentiates between higher and lower cognitive tasking. The collection currently consists of about 670 documents of various types. These include military standards and specifications, reports, conference proceedings, dissertations, technical manuals, books, journal articles, and military instructions and directives. The documents have been added to the library as the result of literature searches and personal submission from team members. It is a selective collection and not a comprehensive one. A database, written in Procite/PC, contains the cataloged holdings of the library. Each record contains the bibliographic information and an abstract. The database provides access to information in the records by either full text searches using Boolean logic or individual field searching. One-word "quick searches" can be performed on the date, title, or author fields. The browsing capability for retrieved items is by full record or brief format. Search results can be read from the screen, printed to hard copy, or transferred to a disk file for later use. Disks containing the database and printed bibliographies are available to PMA205 network team members upon request.

29933 (SAND–89-2813C) **Developing a connector selection database application using NIAM [Nijssen's Information Analysis Methodology].** Sevier, N.E. Sandia National Labs., Albuquerque, NM (USA). [1990]. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-900580–4: 1990 Digital Equipment Corporation User's Society meeting, New Orleans, LA (USA), 7-11 May 1990). Order Number DE90009971. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Nijssen's Information Analysis Methodology (NIAM) is a conceptual information modeling technique that provides a database applications designer with the tools and guidance to develop database applications that accurately depict users needs in a timely manner. The steps involved are: information gathering; information modeling; transformation; data input; and user interface development. This talk will describe how these steps were used to create a connector selection database application. The information gathering step will describe where the information regarding connectors was found. The information modeling step will explain how the information was depict utilizing a NIAM information structure diagram. The transformation step will demonstrate how an information structure diagram can be directly translated into database record structures. The data input step will address methods for capturing all the data. Finally the user interface step will describe the basic user interface along with methods for integrating help text and graphics with a DBMS. 7 refs., 2 figs.

29934 (UCRL–102749) **Pattern classification using self-organizing feature maps.** Lu, Shin-yee. Lawrence Livermore National Lab., CA (USA). Jan 1990. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-9006136–1: International conference on neural networks, San Diego, CA (USA), 17-21 Jun 1990). Order Number DE90008321. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this paper, we demonstrate the use of self-organizing feature maps as pattern classifiers. When a set of training patterns is presented to a self-organizing network repeatedly for many iterations, the weight vectors gradually organize themselves to be the cluster centers of these patterns. In the one dimensional case, they can arrange themselves to satisfy a linear ordering relation. That is, the distance between two weight vectors increases as the physical distance between the two corresponding output nodes increases. However, the latter is true only when an adequate size of neighborhood is used in the network. We notice a cyclic phenomenon among the distances between weight vectors, when the size of the neighborhood is small. 5 refs., 7 figs., 5 tabs.

Corporate Author Index

This index lists the corporate authors responsible for issuing the documents in this publication which are identified primarily by report number. The corporate names are entered in standardized forms as defined in *DOE Energy Data Base: Corporate Author Entries* (DOE/TIC-4585). Each entry under a corporate name includes the document title and citation number. Three items of information may appear in parentheses: (1) an abbreviation to identify the document type, such as a report; (2) the country of publication, also abbreviated; and (3) the language of the document if non-English (R;US;In French). Author affiliations are not listed in this index.

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Aerospace Corp., El Segundo, CA (USA). Chemistry and Physics Lab.
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Aerospace Corp., El Segundo, CA (USA). Electronics Research Lab.
Determining the effects of microwave power and C-field setting on the frequency of a cesium atomic frequency standard. Technical report, 15:29345 (R;US)

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Agricultural Research Service, Phoenix, AZ (USA). Water Conservation Lab.
Effects of air temperature on atmospheric CO_2-plant growth relationships, 15:29196 (R;US)

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AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii
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Nuclear spectroscopy and nuclear structure. Electromagnetic transitions in atomic nuclei: Summaries of report, 15:29506 (R;SU;In Russian)

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AC01-76ET29017	**Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center**	
	15:28749	DOE/ET/29017–T1
AC01-88DP00150	**National Research Council, Washington, DC (USA). Committee to Provide Interim Oversight of the DOE Nuclear Weapons Complex**	
	15:27766	DOE/DP/00150–T1
AC01-89ER80818	**Radiation Monitoring Devices, Inc., Watertown, MA (USA)**	
	15:28889	CONF-891119–119
AC02-76CH00016	**Brookhaven National Lab., Upton, NY (USA)**	
	15:28034	BNL–44443
	15:28041	BNL-NUREG–44323
	15:28464	BNL–44411
	15:28677	BNL–52229
	15:28843	BNL–43944
	15:28844	BNL–44474
	15:28943	BNL-NUREG–44386
	15:28984	BNL–44417
	15:29112	BNL–44468
	15:29517	BNL–44430
	15:29545	BNL-NUREG–44453
	15:29445	BNL–44429
	15:29538	BNL–44431
	USDOE Office of Energy Research, Washington, DC (USA). Materials Sciences Div.	
	15:28484	CONF-900395–1
	Nuclear Regulatory Commission, Washington, DC (USA). Mechanical Engineering Branch	
	15:27962	BNL-NUREG–44440
	15:28517	Published article
	15:28571	Published article
	15:28579	Published article
	15:28681	Published article
	15:29451	Published article
	15:29587	Published article
AC02-76CH03000	**Fermi National Accelerator Lab., Batavia, IL (USA)**	
	15:28793	FNAL-TM–1611
	15:28794	FNAL-TM–1651
	15:28795	FNAL-TM–1653
	15:28847	FNAL-TM–1640
	15:28848	FNAL-TM–1648
	15:28849	FNAL-TM–1650
	15:28882	FNAL-TM–1649
	15:29135	FNAL-TM–1656
	15:29459	FNAL/C–90/43-T
	15:29460	FNAL/C–90/57-T
	15:29598	FNAL-TM–1647
AC02-76CH03073	**Princeton Univ., NJ (USA). Plasma Physics Lab.**	
	15:29677	PPPL–2674
	15:29678	PPPL–2686
	15:29783	Published article
	15:29784	Published article
AC02-76ER01195	**Illinois Univ., Urbana, IL (USA). Dept. of Physics**	
	15:29449	UIUC-HEPG–90-56
	Stanford Linear Accelerator Center, Menlo Park, CA (USA)	
	15:29419	SLAC–343
	15:29453	CONF-8906204–
	15:29457	CONF-8906204–
	15:28519	Published article
	15:28577	Published article
	15:28655	Published article
	15:29122	Published article
	15:29162	Published article
AC02-76ER01545	**Stanford Linear Accelerator Center, Menlo Park, CA (USA)**	
	15:29410	SLAC–343
	15:29456	CONF-8906204–
	15:29486	Published article
	15:29451	Published article
AC02-76ER03274	**Brookhaven National Lab., Upton, NY (USA)**	
	15:29517	BNL–44430
	15:29545	BNL-NUREG–44453
	15:29445	BNL–44429
	15:29538	BNL–44431
	15:29788	Published article
	15:29778	Published article
	15:29779	Published article
	15:29845	Published article
	15:29109	Published article
AC02-82ER12093	**Illinois Univ., Chicago, IL (USA). Dept. of Civil Engineering, Mechanics, and Metallurgy**	
	15:28392	DOE/ER/12093–1
AC02-83CH10093	**Solar Energy Research Inst., Golden, CO (USA)**	
	15:27848	SERI/PR–215-3607
	15:27854	SERI/TP–211-3643
	15:27862	DOE/CH/10093–66
	15:27870	DOE/CH/10093–71
	15:27873	DOE/CH/10093–70
	15:28122	SERI/TP–260-3674
	15:28583	Published article
	15:29381	Published article
AC02-83ER40085	**Stanford Linear Accelerator Center, Menlo Park, CA (USA)**	
	15:29444	SLAC–343
AC02-83ER40107	**Brookhaven National Lab., Upton, NY (USA)**	
	15:29517	BNL–44430
	15:29545	BNL-NUREG–44453
	15:29445	BNL–44429
	15:29538	BNL–44431
	15:29453	CONF-8906204–
	15:29457	CONF-8906204–
AC02-88CH10379	**Carpenter Environmental Associates, Inc., Northvale, NJ (USA)**	
	15:28167	DOE/CH/10379–1

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AC03-76SF00098	**Stanford Linear Accelerator Center, Menlo Park, CA (USA)**	
	15:29400	SLAC–343
	15:29415	SLAC–343
	Lawrence Berkeley Lab., CA (USA)	
	15:27529	LBL–28442
	15:27530	LBL–28443
	15:27697	LBL–28444
	15:28157	LBL-PUB–625-Vol.16
	15:28158	LBL-PUB–625-Vol.17
	15:28159	LBL-PUB–625-Vol.18
	15:28160	LBL-PUB–625-Vol.19
	15:28161	LBL-PUB–625-Vol.21
	15:28162	LBL-PUB–625-Vol.22
	15:28163	LBL-PUB–625-Vol.23
	15:28164	LBL-PUB–625-Vol.24
	15:28165	LBL-PUB–625-Vol.25
	15:29269	LBL–28600
	15:28224	Published article
	15:28453	Published article
	15:28575	Published article
	15:28576	Published article
	15:28588	Published article
	15:28591	Published article
	15:28940	Published article
	15:29363	Published article
	15:29371	Published article
	15:29373	Published article
	15:29616	Published article
	15:29455	CONF-8906204–
	15:29453	CONF-8906204–
	15:29457	CONF-8906204–
	15:29929	Published article
AC03-85SF15935	**Science Applications International Corp., McLean, VA (USA)**	
	15:29339	CONF-8710514–1
AC03-86SF16567	**Electric Power Research Inst., Palo Alto, CA (USA)**	
	15:28007	EPRI-GS/NP–6670
	15:28778	Published article
AC03-88SF17714	**Ackco, Inc., Boulder, CO (USA)**	
	15:28233	DOE/SF/17714–T2
AC03-89ER53277	**General Atomics Co., San Diego, CA (USA)**	
	15:29630	GA-A–20024
	General Atomics, San Diego, CA (USA)	
	15:29631	GA-A–20031
AC04-	**Solar Energy Research Inst., Golden, CO (USA)**	
	15:28122	SERI/TP–260-3674
AC04-76DP00613	**Allied-Signal Aerospace Co., Kansas City, MO (USA). Kansas City Div.**	
	15:28751	KCP–613-4303
	15:28954	KCP–613-4302
AC04-76DP00789	**Sandia National Labs., Albuquerque, NM (USA)**	
	15:27531	SAND–89-2314C
	15:27646	SAND–90-1105C
	15:27721	SAND–86-0090
	15:27722	SAND–88-0474
	15:27723	SAND–89-0011
	15:27724	SAND–89-1441C
	15:27725	SAND–89-1765C
	15:27726	SAND–89-2146C
	15:27727	SAND–89-2175C
	15:27728	SAND–89-2268C
	15:27729	SAND–89-2282C
	15:27730	SAND–89-2322
	15:27731	SAND–89-2347C
	15:27732	SAND–89-2359C
	15:27733	SAND–89-2446C
	15:27859	SAND–90-0183
	15:27874	SAND–89-0790
	15:27974	SAND–89-1064C
	15:28075	SAND–89-2505C
	15:28112	SAND–89-2313C
	15:28113	SAND–89-2567C
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	15:28549	SAND–90-0541C
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	15:28552	SAND–90-0890C
	15:28650	SAND–90-0818C
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	15:28708	SAND–90-0223C
	15:28731	SAND–90-0534C
	15:28759	SAND–89-2425C
	15:28760	SAND–89-2617C
	15:28761	SAND–89-2730C
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	15:28958	SAND–90-0050C
	15:28959	SAND–90-0906C
	15:28970	SAND–89-2382C
	15:29276	SAND–89-2126C
	15:29277	SAND–89-2913C
	15:29355	SAND–90-0202
	15:29376	SAND–89-1927C
	15:29581	SAND–89-2918C
	15:29810	SAND–89-1088
	15:29908	SAND–89-2244C
	15:29909	SAND–89-2383C
	15:29910	SAND–90-0249
	15:29933	SAND–89-2813C
	15:27734	SAND–89-7067
	15:27853	SAND–90-7026
	15:28762	SAND–90-0081C
	USDOE Pittsburgh Energy Technology Center, PA (USA)	
	15:27393	CONF-891081–
	15:27418	CONF-891131–
	15:27438	CONF-891081–
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research	
	15:28015	NUREG/CR–4691-Vol.1
	New Mexico Univ., Albuquerque, NM (USA). Dept. of Electrical and Computer Engineering	
	15:28550	SAND–90-0608C
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of High-Level Waste Management	
	15:27700	NUREG/CR–5393
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Low-Level Waste Management	
	15:27702	NUREG/CR–5517
	15:28590	CONF-890723–
	15:28842	CONF-890723–
	15:28923	CONF-890723–
	15:28924	CONF-890723–
	15:28450	Published article
	15:28454	Published article
	15:28574	Published article
	15:28584	Published article
	15:28586	Published article
	15:28663	Published article
	15:28664	Published article
	15:28692	Published article
	15:28961	Published article

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AC04-76DR00789	**Stanford Univ., CA (USA). Thermosciences Div.**	
	15:28283	SAND–90–8201
AC04-88DP43495	**EG and G Mound Applied Technologies, Miamisburg, OH (USA)**	
	15:28543	MLM–3631
	15:28752	MLM-MU–90-64-0003
	15:28516	Published article
AC05-76OR00001	**Portsmouth Gaseous Diffusion Plant, OH (USA)**	
	15:28725	POEF-T–3522
	Martin Marietta Energy Systems, Inc., Piketon, OH (USA)	
	15:27720	POEF-T–3525
	15:29928	Published article
AC05-84OR21400	**Nucleo de Estudos e Pesquisas Cientificas do Rio de Janeiro, RJ (Brazil)**	
	15:29170	CONF-900608–4
	Oak Ridge Gaseous Diffusion Plant, TN (USA)	
	15:28248	K/D–5834
	Oak Ridge National Lab., TN (USA)	
	15:27565	ORNL/FTR–3571
	15:27675	CONF-900608–11
	15:27676	CONF-900690–1
	15:27704	ORNL/M–1110
	15:27758	CONF-9002111–1
	15:27760	ORNL/TM–11431
	15:27782	CONF-900607–3
	15:27785	ORNL/TM–11497
	15:27786	CONF-9003100–3
	15:27971	CONF-900607–2
	15:27988	CONF-900608–13
	15:27993	ORNL/M–1120
	15:28022	CONF-900608–5
	15:28042	CONF-900607–4
	15:28043	CONF-900608–12
	15:28045	CONF-900617–8
	15:28074	ORNL/FTR–3592
	15:28095	ORNL/FTR–3583
	15:28104	CONF-9004176–1
	15:28116	DOE/OR/21400–T418
	15:28226	CONF-9006117–1
	15:28227	CONF-9006117–2
	15:28228	CONF-9006117–3
	15:28251	ORNL/FTR–3587
	15:28285	CONF-900676–3
	15:28386	CONF-900466–5
	15:28387	CONF-900466–6
	15:28389	CONF-900617–7
	15:28390	CONF-9006149–1
	15:28391	CONF-9006162–1
	15:28466	CONF-891119–120
	15:28467	CONF-891119–121
	15:28468	CONF-891119–122
	15:28494	ORNL/FTR–3597
	15:28532	CONF-900466–7
	15:28533	CONF-9006122–5
	15:28534	CONF-9006135–1
	15:28610	ORNL/TM–11282
	15:28696	CONF-900608–10
	15:28697	CONF-8910387–1
	15:28698	CONF-9005155–1
	15:28723	ORNL/FTR–3573
	15:28879	ORNL/FTR–3577
	15:28912	ORNL/FTR–3576
	15:28913	ORNL/FTR–3585
	15:28928	CONF-9004173–2
	15:28963	CONF-9006165–1
	15:28986	CONF-9006117–4
	15:29048	ORNL/FTR–3596
	15:29049	ORNL/TM–11470
	15:29065	CONF-9004173–1
	15:29070	ORNL–6602
	15:29071	ORNL/TM–11368
	15:29142	ORNL/TM–11427
	15:29146	ORNL–6614
	15:29180	ORNL/FTR–3567
	15:29181	ORNL/TM–11424
	15:29346	CONF-900289–4
	15:29347	CONF-900466–15
	15:29510	ORNL/FTR–3575
	15:29511	ORNL/FTR–3586
	15:29512	ORNL/FTR–3591
	15:29541	CONF-900608–2
	15:29542	CONF-900608–6
	15:29568	CONF-900608–8
	15:29575	CONF-900466–8
	15:29576	CONF-900684–2
	15:29623	CONF-900557–1
	15:29624	CONF-900602–1
	15:29625	CONF-900602–3
	15:29792	CONF-891007–Vol.1
	15:29793	CONF-891007–Vol.2
	15:29794	CONF-900602–2
	15:29795	CONF-900602–4
	15:29796	CONF-900623–3
	15:29797	CONF-9003116–1
	15:29798	CONF-9006162–2
	15:29848	CONF-9004177–1
	15:29854	ORNL/Sub–7685/1-T23
	15:29884	CONF-900652–1
	15:29885	CONF-9006167–1
	15:29932	ORNL/TM–11534
	15:27705	ORNL/Sub–86-SA094/4
	15:27706	ORNL/Sub–86-SA094/5
	15:27708	ORNL/Sub–86-SA094/8
	15:28252	ORNL/Sub–88-SD731/1
	15:28730	ORNL/Sub–87-SA946/01
	15:29626	CONF-900602–5
	Solar Energy Research Inst., Golden, CO (USA)	
	15:28122	SERI/TP–260-3674
	USDOE Pittsburgh Energy Technology Center, PA (USA)	
	15:27403	CONF-891081–
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering	
	15:27701	NUREG/CR–5463
	Nuclear Regulatory Commission, Washington, DC (USA). Office for Analysis and Evaluation of Operational Data	
	15:27987	NUREG/CR–2000-Vol.9-No.2
	Oak Ridge National Lab., TN (USA). Carbon Dioxide Information Analysis Center	
	15:28997	ORNL/CDIAC–31
	Johnson (E.R.) Associates, Inc., Oakton, VA (USA)	
	15:27707	ORNL/Sub–86-SA094/7
	15:29059	CONF-8904177–
	15:28448	Published article
	15:28455	Published article
	15:28456	Published article
	15:28580	Published article
	15:28582	Published article
	15:28691	Published article
	15:29110	Published article
AC05-84OT21400	**Oak Ridge Gaseous Diffusion Plant, TN (USA)**	
	15:28060	K/CSD/INF–89/40
AC05-85ER40216	**Maryland Univ., College Park, MD (USA)**	
	15:28836	CONF-890335–276

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	15:28837	CONF-890335–277
	15:28838	DOE/ER/40216–7
	15:28846	CONF-890197–13
AC05-86OR21600	**Westinghouse Materials Co. of Ohio, Cincinnati, OH (USA). Feed Materials Production Center**	
	15:27658	FMPC–2190
	15:27769	FMPC–2114-Rev.2
AC06-76RL01830	**Oak Ridge National Lab., TN (USA)**	
	15:27914	ORNL/FMP–89/2
	Westinghouse Hanford Co., Richland, WA (USA)	
	15:27743	WHC-SP–0221
	Electric Power Research Inst., Palo Alto, CA (USA)	
	15:27968	EPRI-NP–6774
	Pacific Northwest Lab., Richland, WA (USA)	
	15:27712	PNL–7152
	15:27713	PNL–7282
	15:27714	PNL–7305
	15:27715	PNL–7306-Vol.1
	15:27716	PNL–7306-Vol.2
	15:27717	PNL-SA–17402
	15:27718	PNL-SA–17523
	15:27719	PNL-SA–17574
	15:27761	PNL–7271
	15:27846	PNL–7289
	15:28125	PNL–6880
	15:28133	PNL–7292
	15:28648	PNL–7281
	15:28956	PNL-SA–17849
	15:29017	PNL–7208
	15:29018	PNL–7311
	15:29019	PNL–7312
	15:29052	PNL–7270
	15:29053	PNL–7291
	15:29182	PNL-SA–17384-HEDR
	15:29855	PNL-MA–70-Vol.1
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	15:29906	PNL–7301
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering	
	15:28068	NUREG/CR–4882
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Regulatory Applications	
	15:28911	NUREG/CR–5540
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Low-Level Waste Management and Decommissioning	
	15:27703	NUREG/CR–5547
	Pacific Northwest Lab., Richland, WA (USA). Environmental Management Operations	
	15:29044	EMO–1007
AC06-87RL10930	**Westinghouse Hanford Co., Richland, WA (USA)**	
	15:27738	WHC-EP–0300
	15:27739	WHC-EP–0324
	15:27740	WHC-EP–0331
	15:27741	WHC-SA–0560
	15:27742	WHC-SA–0891
	15:27744	WHC-SP–0463
	15:28016	WHC-SP–0017-3
	15:28017	WHC-SP–0071
	15:28018	WHC-SP–0114
	15:28019	WHC-SP–0407
	15:28027	WHC-SA–0475
	15:28028	WHC-SA–0683
	15:28029	WHC-SA–0741
	15:28077	WHC-SP–0017-2
	15:28078	WHC-SP–0096
	15:28079	WHC-SP–0457
	15:29107	WHC-EP–0145-1
	15:29814	WHC-SA–0693
	15:28076	WHC-SP–0001
	USDOE Richland Operations Office, WA (USA)	
	15:27679	DOE/RL–88-32-Rev.1
	15:28011	DOE/RL–90-15
	15:28047	DOE/RL–90-14
AC07-76ID01570	**Argonne National Lab., IL (USA)**	
	15:29539	CONF-900450–2
	Southwest Research Inst., San Antonio, TX (USA)	
	15:28952	EGG-M–90028
	Solar Energy Research Inst., Golden, CO (USA)	
	15:28122	SERI/TP–260-3674
	EG and G Idaho, Inc., Idaho Falls, ID (USA)	
	15:27653	EGG-M–89049
	15:27671	EGG-NERD–7444-Rev.2
	15:27680	EGG-M–89029
	15:27681	EGG-M–89195
	15:27682	EGG-M–89352
	15:27683	EGG-M–89371
	15:27684	EGG-M–89477
	15:27685	EGG-M–89491
	15:27686	EGG-M–90030
	15:27687	EGG-M–90045
	15:27688	EGG-PRA–4032
	15:27689	EGG-WM–8727-Rev.1
	15:27768	EGG-CPE–8880
	15:27896	EGG-M–89435
	15:27964	EGG-EAST–8580
	15:27965	EGG-M–89008
	15:27991	EGG-NE–8863
	15:28006	EGG-M–89492
	15:28013	EGG-EAST–8663
	15:28014	EGG-NE–8896
	15:28030	EGG-EAST–8461
	15:28049	EGG-EAST–8336
	15:28050	EGG-EAST–8385
	15:28051	EGG-EAST–8426
	15:28052	EGG-EAST–8449
	15:28053	EGG-M–89005
	15:28054	EGG-M–89359
	15:28055	EGG-SSRE–8875
	15:28091	EGG-EE–8651
	15:28108	EGG-EP–8917
	15:28109	EGG-EP–8918
	15:28149	BP–587-0390-2M-T
	15:28192	EGG-M–89411
	15:28395	EGG-MS–8865
	15:28488	EGG-M–90043
	15:28750	EGG-M–89350
	15:28929	EGG-M–89047
	15:28930	EGG-M–89050
	15:28931	EGG-M–90092
	15:29174	EGG-BNCT–8777
	15:29853	EGG-M–90062
	Fauske and Associates, Inc., Burr Ridge, IL (USA)	
	15:28046	DOE/ID–10258
	EG and G Idaho, Inc., Idaho Falls, ID (USA). Center for Environmental Monitoring and Assessment	
	15:29165	EGG-CEMA–8924

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	EG and G Idaho, Inc., Idaho Falls, ID (USA). Computer Applications and Technology Transfer Group	
	15:29891	EGG-CATT-8898
	15:29892	EGG-CATT-8926
	15:29567	Published article
AC08-88NV10617	**EG and G Energy Measurements, Inc., Pleasanton, CA (USA)**	
	15:28989	EGG-10617-4101
AC08-89NV10630	**Reynolds Electrical and Engineering Co., Inc., Las Vegas, NV (USA)**	
	15:29571	CONF-900679-1
	Reynolds Electrical and Engineering Co., Inc., Las Vegas, NV (USA). Environment and Health Div.	
	15:29171	CONF-8904186-2
AC09-76SR00001	**Savannah River Lab., Aiken, SC (USA)**	
	15:28012	DPST-88-927
	15:29060	Published article
AC09-89SR18035	**Savannah River Lab., Aiken, SC (USA)**	
	15:28012	DPST-88-927
	Westinghouse Savannah River Co., Aiken, SC (USA)	
	15:27670	WSRC-RP-89-812
	15:27746	WSRC-RP-89-955
	15:27747	WSRC-RP-89-1328
	15:28020	WSRC-RP-89-817
	15:28032	WSRC-RP-89-1270
	15:28033	WSRC-RP-89-1380
	15:28143	WSRC-MS-90-07
	15:28727	WSRC-RP-89-1438
	15:27745	WSRC-RP-89-0920
AC21-84MC21181	**Geoexplorers International, Inc., Denver, CO (USA)**	
	15:27586	DOE/MC/21181-1950-Vol.15
AC21-86MC21023	**Foster Wheeler Development Corp., Livingston, NJ (USA)**	
	15:27486	DOE/MC/21023-2758-Vol.1
AC21-86MC23256	**Texas A and M Univ., College Station, TX (USA). Dept. of Mechanical Engineering**	
	15:27487	DOE/MC/23256-2787-Vol.1
AC22-82PC50041	**USDOE Pittsburgh Energy Technology Center, PA (USA)**	
	15:27392	CONF-891081-
AC22-84PC60417	**Avco-Everett Research Lab., Everett, MA (USA)**	
	15:27488	DOE/PC/60417-T1
AC22-84PC70002	**USDOE Pittsburgh Energy Technology Center, PA (USA)**	
	15:27396	CONF-891081-
AC22-84PC70507	**Avco-Everett Research Lab., Everett, MA (USA)**	
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AC22-84PC70508	**TRW Space and Technology Group, Redondo Beach, CA (USA). Applied Technology Div.**	
	15:28216	DOE/PC/70508-T4
AC22-85BC10841	**Texas Univ., Austin, TX (USA). Dept. of Engineering**	
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AC22-85PC80011	**USDOE Pittsburgh Energy Technology Center, PA (USA)**	
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AS05-76ER03956	**Stanford Linear Accelerator Center, Menlo Park, CA (USA)**	
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FG22-86PC90502	Alabama Univ., University, AL (USA). Dept. of Chemistry	
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FG22-87PC79935	West Virginia Univ., Morgantown, WV (USA). Dept. of Mechanical and Aerospace Engineering	
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FG22-88PC88910	Arkansas Tech Univ., Russellville, AR (USA). Arkansas Mining and Mineral Resources Research Inst.	
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FG22-88PC88912	California State Univ., Long Beach, CA (USA)	
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FG22-88PC88920	Idaho Univ., Moscow, ID (USA). Coll. of Mines and Earth Resources	
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FG22-88PC88929	Cornell Univ., Ithaca, NY (USA). Sibley School of Mechanical and Aerospace Engineering	
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FG22-89BC14250	Illinois Dept. of Energy and Natural Resources, Springfield, IL (USA)	
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216960/5/XAB	15:28364	NTIS, PC A03/MF A01			
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216990/2/XAB	15:28746	NTIS, PC A01/MF A01			
217002/5/XAB	15:28035	NTIS, PC A03/MF A01			
217017/3/XAB	15:29113	NTIS, PC A03/MF A01			
217020/7/XAB	15:29262	NTIS, PC A11/MF A02			
217036/3/XAB	15:28747	NTIS, PC A02/MF A01			
217056/1/XAB	15:29864	NTIS, PC A02/MF A01			
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2588	15:28694	H.M. Stationery Office, price Pound 8.00			
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2350	15:27958	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90625044	
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AEL–					
13	15:28284	NTIS (US Sales Only), PC A05/MF A01		DE90780109	
AFOEHL–					
89-089EQ0144HEF	15:28980	*See* AD-A–216690/8/XAB			
AGS/AD–					
90-1	15:28843	*See* BNL–43944			
ANL-PHY–					
89/1	15:29544	NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010252	MF-413
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7	15:29930	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009372	
ANL/ER–					
1	15:28982	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010154	PC-402
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114	15:29505	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009518	MF-413
ATR–					
89(4752)-3	15:28523	*See* AD-A–216527/2/XAB			
BFR-R–					
107-1989	15:28225	NTIS (US Sales Only), PC A10/MF A01		DE90770874	
69-1989	15:28530	NTIS (US Sales Only), PC A05/MF A01		DE90770873	
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89(21)	15:29082	*See* PB–90-159393/XAB			
BMU–					
1988-236	15:28983	GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, (Germany, F.R.)			
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87-26-App.	15:28117	*See* DOE/BP/63406–4			
88-28	15:27879	*See* DOE/BP/63406–6			
89-29-Vol.1	15:28189	*See* DOE/BP/63406–7			
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BUMINES-RI–					
9270	15:27479	*See* PB–90-157132/XAB			
9274	15:29001	*See* PB–90-157108/XAB			
9276	15:27522	*See* PB–90-170648/XAB			
9282	15:27433	*See* PB–90-170655/XAB			
9283	15:27481	*See* PB–90-170663/XAB			
CBCS–					
90-1	15:28069	*See* NUREG/CR–5438			
CCMS–					
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CCOFI–					
90009969	15:29147	CalCOFI, California Department of Fish and Game, 330 Golden Shore, Suite 50, Long Beach, CA 90802			
CE–					
02886	15:28261	*See* SCC–25(81-66)			
02891	15:27867	*See* SA–CE02891			
02896	15:28250	*See* NBES–101			
02905	15:28126	*See* SEG–CE02905			
02929	15:28336	*See* SEMR–11			
02952	15:27836	*See* PJM–CE02952			
02953	15:27580	*See* CGA–CE02953			
02959	15:27844	*See* SHEC–CE02959			
02977	15:27796	*See* NBES–2067			
02989	15:27797	*See* NBU/FF–2023			
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9975	15:28845	NTIS (US Sales Only), PC A03/MF A01		DE90773403	
9977	15:27662	NTIS (US Sales Only), PC A02/MF A01		DE90773404	
9978	15:27663	NTIS (US Sales Only), PC A02/MF A01		DE90773405	
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CEAC-R–					
4-89	15:29041	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90624445	

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0017/R89	15:28682	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624254	
0031/R89	15:27995	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624978	
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6167/R89	15:29042	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624681	
6201/R89	15:29043	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624682	
6217/R89	15:27996	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90624979	
6222/R89	15:27997	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624980	
6230/R89	15:28371	NTIS (US Sales Only), PC A06/MF A01; OSTI; INIS		DE90624388	
CEGB-RD/L–					
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3486/R89	15:27757	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624691	
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1832/RR89	15:28372	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624313	
CERN-Th–					
5485/89	15:29476	*See* UWThPh–1989-41			
CETHA-TE-CR–					
90002	15:29044	*See* EMO–1007			
CGA–					
CE02953	15:27580	Canadian Gas Association, 55 Scarsdale Rd., Don Mills, ON, CAN M3B 2R3. Prices: PRICES UPON REQUEST			
CH–					
405/89	15:28647	*See* OEFZS-A–1570			
CIEMAT–					
623	15:28683	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624258	
635	15:28985	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624489	
CONF-8211204–					
	15:27836	*See* PJM–CE02952			
CONF-8502162–		(3. colloquium on sprayed concrete for tunneling and mining; Bochum (Germany, F.R.); 13 Feb 1985)			
	15:28735	*See* KIB-RUB-TWM–85-6			
CONF-8510516–		(Workshop on the role of sulfur species on the secondary-side degradation of alloy 600 and related alloys; Baltimore, MD (USA); 16-18 Oct 1985)			
Summs.	15:27955	*See* EPRI-NP–6710-M			
CONF-8708178–		(Symposium on chemistry in high temperature aqueous solutions; Provo, UT (USA); 25-27 Aug 1987)			
	15:27954	*See* EPRI-NP–6005			
CONF-870941–		(2. international conference on new frontiers for hazardous waste management; Pittsburgh, PA (USA); 27-30 Sep 1987)			
	15:28312	Environmental Protection Agency (US), 26 W. St. Clair St., Cincinnati, OH 45268 (USA)			
CONF-8710514–		(Chapman conference; Sendai (Japan); 12-16 Oct 1987)			
1	15:29339	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009459	MF-712
CONF-8803253–		(3. annecy meeting in theoretical physics on conformal field theory and related topics; Annecy (France); 14-16 Mar 1988)			
	15:29488	*See* CEA-CONF–9521			
	15:29489	*See* CEA-CONF–9522			
CONF-880403–		(American power conference; Chicago, IL (USA); 18-20 Apr 1988)			
	15:27508				
	15:27939				

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	15:27940				
	15:27949				
	15:28780				
CONF-8804112–		(Interfacial structure, properties and designs in solids; Reno, NV (USA); 5-9 Apr 1988)			
	15:28498	Materials Research Society, 9800 Mc Knight Rd., Suite 327, Pittsburgh, PA 15237 (USA)			
CONF-8804117–		(Adhesion in solids; Reno, NV (USA); 5-7 Apr 1988)			
	15:28556	Materials Research Society, 9800 Mc Knight Rd., Suite 327, Pittsburgh, PA 15237 (USA)			
CONF-8805140–		(International conference on medium- and high-energy nuclear physics; Taipei (Taiwan); 23-27 May 1988)			
	15:29458	*See* CEA-CONF–9578			
CONF-880607–		(33. ASME international gas turbine and aero-engine congress and exposition; Amsterdam (Netherlands); 5-8 Jun 1988)			
	15:28497	American Society of Mechanical Engineers, 345 East 47 St., New York, NY 10017 (USA)			
CONF-880679–		(81. annual meeting of Air Pollution Control Association; Dallas, TX (USA); 19-24 Jun 1988)			
	15:27945	Air Pollution Control Assoc., Publishing Department, P.O. Box 2861, Pittsburgh, PA 15230 (USA)			
	15:27946	Air Pollution Control Assoc., Publishing Department, P.O. Box 2861, Pittsburgh, PA 15230 (USA)			
	15:28144	Air Pollution Control Assoc., Publishing Department, P.O. Box 2861, Pittsburgh, PA 15230 (USA)			
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	15:29035	Air Pollution Control Assoc., Publishing Department, P.O. Box 2861, Pittsburgh, PA 15230 (USA)			
	15:29250	Air Pollution Control Assoc., Publishing Department, P.O. Box 2861, Pittsburgh, PA 15230 (USA)			
CONF-880812–		(Applied superconductivity conference; San Francisco, CA (USA); 21-25 Aug 1988)			
	15:28781				
CONF-8809413–		(3. national conference on the environmental and public health effects of soils contaminated with petroleum products; Amherst, MA (USA); 19-21 Sep 1988)			
	15:27573	Lewis Publishers, 121 South Main St., P.O. Drawer 519, Chelsea, MI 48118 (USA)			
CONF-8810329–		(International conference on recent advances in track physics; Lincoln, NE (USA); 18-20 Oct 1988)			
	15:28892	*See* DOE/ER/60741–1			

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CONF-8810352–		(Meeting on metals research and development: applications in the field of energy in Italy; Milan (Italy); 19-20 Oct 1988)			
	15:27941	NTIS (US Sales Only), PC A13/MF A01		DE90764258	
CONF-8810423–		(Latin American conference on the applications of the Moessbauer Effect; Rio de Janeiro (Brazil); 31 Oct - 4 nov 1988)			
1	15:29591	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010411	MF-413
CONF-8810489–		(7. All-Union conference on physicochemical analysis; Frunze (USSR); 4-6 Oct 1988)			
	15:28600	*See* INIS-SU–162			
CONF-8810498–		(Workshop on the experiments by polarized proton and electron beams; Tsukuba (Japan); 27-28 Oct 1988)			
	15:29508	*See* KEK–89-12			
CONF-8812133–		(Conference on the biogas process in the Nordic countries: research and application; Uppsala (Sweden); 6-7 Dec 1988)			
	15:27807	*See* SLU-IMB–40			
CONF-890103–		(6. symposium on space nuclear power systems; Albuquerque, NM (USA); 9-12 Jan 1989)			
13	15:27974	*See* SAND–89-1064C			
CONF-8901185–		(Seminar on Energy meeting in Middle-Finland '89: energy and society; Jyvaeskylae (Finland); 19 Jan 1989)			
	15:27894	*See* NEI-FI–90			
CONF-8901187–		(Workshop on the cooling of high-performance reactors; Kumatori (Japan); 17-18 Jan 1989)			
	15:28000	*See* KURRI-TR–327			
CONF-890173–		(1. international RELAP-5 users seminar; College Station, TX (USA); 31 Jan - 2 feb 1989)			
6	15:28053	*See* EGG-M–89005			
CONF-890197–		(Workshop on advanced accelerator concepts; Lake Arrowhead, CA (USA); 9-13 Jan 1989)			
13	15:28846	NTIS, PC A03/MF A01; OSTI; INIS		DE90009991	MF-414
CONF-890207–		(Waste management '89: 15th international waste management symposium conference; Tucson, AZ (USA); 26 Feb - 2 mar 1989)			
37	15:27682	*See* EGG-M–89352			
38	15:27680	*See* EGG-M–89029			
39	15:27683	*See* EGG-M–89371			
CONF-8902175–		(1. PBWU status seminar on forest decline; Neuherberg (Germany, F.R.); 27 Feb - 1 mar 1989)			
	15:29198	*See* GSF–6/89			
CONF-8902176–		(1. symposium on networking; Tsukuba (Japan); 6-7 Feb 1989)			
	15:29894	*See* KEK–89-3			
CONF-890299–		(1989 Advanced Hadron Facility accelerator design workshop; Los Alamos, NM (USA); 20-25 Feb 1989)			
Vol.1	15:28796	*See* LA–11684-C-Vol.1			
Vol.2	15:28797	*See* LA–11684-C-Vol.2			
CONF-890302–		(16. European conference on controlled fusion and plasma physics; Venice (Italy); 13-17 Mar 1989)			
	15:29679	*See* Rijnhuizen-report–89-181			
CONF-8903172–		(10. two-yearly meeting on nuclear physics; Aussois (France); 6-10 Mar 1989)			
	15:29349	*See* LYCEN–89-06			
CONF-890318–		(Joint symposium on stationary combustion nitrogen oxide control; San Francisco, CA (USA); 6-9 Mar 1989)			
Summ.	15:29024	*See* SVF–354			
CONF-8903207–		(15. Czechoslovak seminar on plasma physics and technology; Liblice (Czechoslovakia); 13-17 Mar 1989)			
	15:29622	*See* IPPCZ–293/I			
CONF-8903211–		(Workshop on cyclotron cascade project; Ibaraki (Japan); 13-15 Mar 1989)			
	15:29513	*See* RCNP-P–107			

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CONF-890331–		(40. Pittsburgh conference and exposition on analytical chemistry and applied spectroscopy; Atlanta, GA (USA); 6-10 Mar 1989)			
	15:28888	*See* CEA-CONF–9970			
CONF-890335–		(1989 IEEE particle accelerator conference; Chicago, IL (USA); 20-23 Mar 1989)			
276	15:28836	NTIS, PC A02/MF A01; OSTI; INIS		DE90009993	MF-414
277	15:28837	NTIS, PC A02/MF A01; OSTI; INIS		DE90009992	MF-414
CONF-8904177–		(Symposium on innovative waste management technologies; Dallas, TX (USA); 9-14 Apr 1989)			
	15:29059				
CONF-8904186–		(Wildland shrub symposium; Las Vegas, NV (USA); 5 Apr 1989)			
2	15:29171	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009417	MF-702
CONF-8904240–		(40. Society of Automotive Engineers annual earthmoving industry conference; Peoria, IL (USA); 11-13 Apr 1989)			
	15:27579	Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096 (USA)			
	15:28347	Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096 (USA)			
CONF-8904335–		(2. EPRI annual utility strategic issues forum: what does the future hold for the electricity business?; Kansas City, MO (USA); 11-12 Apr 1989)			
	15:28195	*See* EPRI-OCSP–6757			
CONF-8904337–		(39. conference on nuclear spectroscopy and nuclear structure; Tashkent (USSR); 18-21 Apr 1989)			
	15:29506	*See* INIS-SU–166			
CONF-8905141–		(5. international conference on electrostatic accelerators and associated boosters; Strasbourg (France); 24-27 May 1989)			
	15:28845	*See* CEA-CONF–9975			
CONF-8905194–		(4. Pisa meeting on advanced detectors: frontier detectors from frontier physics; La Biodola (Italy); 21-26 May 1989)			
	15:28909	*See* LPNHE–89-04			
CONF-8905306–		(Transmission and distribution automation systems conference; King of Prussia, PA (USA); 22-24 May 1989)			
	15:28092	*See* EPRI-EL–6762			
CONF-890583–		(Symposium on the occasion of the 40th anniversary of the nuclear shell model; Argonne, IL (USA); 25-27 May 1989)			
	15:29546	Elsevier Science Publishers B.V., P.O. Box 103, 1000 AC, Amsterdam, The Netherlands			ND-413
Pt.2	15:29544	*See* ANL-PHY–89/1			
CONF-890610–		(American Solar Energy Society annual meeting; Denver, CO (USA); 19-23 Jun 1989)			
	15:27868				
CONF-890617–		(2. Karlsruhe international conference on analytical chemistry in nuclear technology; Karlsruhe (Germany, F.R.); 5-9 Jun 1989)			
	15:27662	*See* CEA-CONF–9977			
	15:27663	*See* CEA-CONF–9978			
	15:27665	*See* DNE-R–14			
	15:27666	*See* DNE-R–15			
CONF-8906204–		(International symposium on heavy quark physics; Ithaca, NY (USA); 13-17 Jun 1989)			
	15:29453				
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CONF-8906295–		(10. university conference on glass science; State College, PA (USA); Jun 1989)			
1	15:28496	*See* SAND–89-0183C			
CONF-8906312–		(17. Inter-RAM conference; Hershey, PA (USA); 12-15 Jun 1989)			
1	15:27896	*See* EGG-M–89435			
CONF-8906313–		(28. annual gas measurement school; London (Canada); 13-15 Jun 1989)			
	15:27580	*See* CGA–CE02953			
CONF-890717–		(EWEC '89: European wind energy conference and exhibition; Glasgow (UK); 10-13 Jul 1989)			
Exc.	15:27883	*See* RISO-M–2824			
CONF-890718–		(International conference on materials and mechanisms of superconductivity - high-temperature superconductors II; Stanford, CA (USA); 23-28 Jul 1989)			
	15:28465	*See* CEA-CONF–9962			
CONF-8907187–		(IFAC: international symposium on advanced nformation processing in automatic control; Nancy (France); 3-7 Jul 1989)			
	15:29264	*See* CEA-CONF–9961			
CONF-8907188–		(Workshop on K-decay experiments; Tsukuba (Japan); 11-12 Jul 1989)			
	15:29446	*See* KEK–89-7			
CONF-890723–		(26. annual conference on nuclear and space radiation effects; Marco Island, FL (USA); 25-29 Jul 1989)			
	15:28520				
	15:28587				
	15:28590				
	15:28842				
	15:28921				
	15:28922				
	15:28923				
	15:28924				
	15:28925				
	15:28926				
	15:28927				
	15:29791				
CONF-8908189–		(Workshop on probabilistic methods in quantum field theory and quantum gravity; Cargese (France); 21-27 Aug 1989)			
	15:29493	*See* NBI-HE–89-62			
CONF-8908222–		(3. international conference on laser interferometry; San Diego, CA (USA); 6-11 Aug 1989)			
1	15:28930	*See* EGG-M–89050			
3	15:27653	*See* EGG-M–89049			
4	15:28929	*See* EGG-M–89047			
CONF-8908223–		(1. All-Union conference on radiobiology; Moscow (USSR); 21-27 Aug 1989)			
	15:29175	*See* INIS-SU–164			
CONF-8908224–		(Optoelectronics: Ernst Abbe conference; Jena (German Democratic Republic); 21-26 Aug 1989)			
1	15:28894	*See* JINR–D13-89-548			
2	15:28895	*See* JINR–D13-89-549			
3	15:28896	*See* JINR–D13-89-550			
CONF-890826–		(International nuclear physics and cosmology conference; Sao Paulo (Brazil); 20-26 Aug 1989)			
	15:29519	*See* GANIL-P–89-16			
CONF-890866–		(11. international conference on boundary element methods in engineering (BEM-11); Boston, MA (USA); 29-31 Aug 1989)			
2	15:29600	*See* JINR–E11-89-442			
CONF-890872–		(Workshop on physics at Fermilab in the 1990's; Breckenridge, CO (USA); 15-24 Aug 1989)			
11	15:29459	*See* FNAL/C–90/43-T			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8909225–		(Actinides '89; Tashkent (USSR); 24-29 Sep 1989)			
3	15:29265	*See* JINR–E6-89-725			
CONF-8909290–		(Risk management symposium; Whippany, NJ (USA); 6-7 Sep 1989)			
2	15:29853	*See* EGG-M–90062			
CONF-8909298–		(NATO conference on cellular automata; Los Alamos, NM (USA); 6-9 Sep 1989)			
3	15:29112	*See* BNL–44468			
CONF-8909300–		(9. summer school on nuclear physics, neutron physics and nuclear energy conference; Varna (Bulgaria); 28 Sep - 7 oct 1989)			
	15:29549	*See* KFK–4655			
CONF-8909316–		(Workshop on the proposed pulse radiolysis facility; Upton, NY (USA); 8-9 Sep 1989)			
Summ.	15:28677	*See* BNL–52229			
CONF-891006–		(Joint international waste management conference; Kyoto (Japan); 23-28 Oct 1989)			
16	15:27681	*See* EGG-M–89195			
CONF-891007–		(13. IEEE symposium on fusion engineering; Knoxville, TN (USA); 2-6 Oct 1989)			
Vol.1	15:29792	IEEE Service Center, Single Publications Sales Dept., 445 Hoes Lane, Piscataway, NJ 08855-1331			ND-420
Vol.2	15:29793	IEEE Service Center, Single Publications Sales Department, 445 Hoes Lane, Piscataway, NJ 08855-1331			ND-420
CONF-8910275–		(1989 Electric Power Research Institute PCB seminar; San Diego, CA (USA); 3-6 Oct 1989)			
	15:28103	*See* EPRI-EL/GS/EN–6792			
CONF-8910385–		(US-Finnish meeting on science and technology; Helsinki (Finland); 23-26 Oct 1989)			
1	15:28150	*See* NEI-FI–93			
CONF-8910386–		(1. topic oriented technical meeting; Amsterdam (Netherlands); 11-17 Oct 1989)			
1	15:28887	*See* STEV-FGT–90-1			
CONF-8910387–		(9. College Park colloquium: a lunar-based chemical analysis conference; College Park, MD (USA); 30-31 Oct 1989)			
1	15:28697	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009401	MF-401; MF-406
CONF-8910393–		(Workshop for asymmetric B-factory at KEK; Tsukuba (Japan); 2-4 Oct 1989)			
	15:29447	*See* KEK–89-17			
CONF-891052–		(Atomic processes in plasmas; Gaithersburg, MD (USA); 2-5 Oct 1989)			
2	15:29333	*See* UCRL-JC–103348			
CONF-891055–		(5. international symposium on the production and neutralization of negative ions and beams; Upton, NY (USA); 30 Oct - 3 nov 1989)			
15	15:28844	*See* BNL–44474			
CONF-891075–		(2. international conference on engineering management; Toronto (Canada); 16-18 Oct 1989)			
	15:28126	*See* SEG–CE02905			
CONF-891094–		(International conference on accelerator and large experimental physics control systems; Vancouver (Canada); 30 Oct - 3 nov 1989)			
17	15:28882	*See* FNAL-TM–1649			
CONF-891097–		(High powered microwave and broadband radio frequency propagation/phenomenology/methodology workshop; Livermore, CA (USA); 23-26 Oct 1989)			
5	15:28763	*See* UCRL–101792			
CONF-891106–		(31. annual meeting of the Division of Plasma Physics of the American Physical Society; Anaheim, CA (USA); 13-17 Nov 1989)			
11	15:29677	*See* PPPL–2674			
CONF-8911179–		(6. Amsterdam miniconference; Amsterdam (Netherlands); 16-17 Nov 1989)			
1	15:29518	*See* DOE/ER/40415–12			

CONF-8911182–

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8911182–		(1989 seminar on nuclear data; Tokai (Japan); 16-17 Nov 1989)			
	15:29507	*See* JAERI-M–90-025			
CONF-8911183–		(Public workshop on nuclear power plant license renewal; Reston, VA (USA); 13-14 Nov 1989)			
Summ.	15:27986	*See* NUREG/CP–0108			
CONF-891119–		(Materials Research Society fall meeting; Boston, MA (USA); 27 Nov - 2 dec 1989)			
118	15:27736	*See* UCRL–101107			
119	15:28889	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009562	MF-406
120	15:28466	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009565	MF-404
121	15:28467	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009828	MF-404
122	15:28468	NTIS, PC A02/MF A01 - OSTI		DE90009861	MF-404
CONF-891164–		(3. biannual conference on the laser vs the electron beam in welding, cutting and surface treatment; Reno, NV (USA); 1-5 Nov 1989)			
1	15:28413	*See* UCRL–99432			
CONF-891208–		(Winter annual meeting of the American Society of Mechanical Engineers; San Francisco, CA (USA); 10-15 Dec 1989)			
30	15:27965	*See* EGG-M–89008			
CONF-891261–		(International conference on lasers '89; New Orleans, LA (USA); 3-8 Dec 1989)			
9	15:28750	*See* EGG-M–89350			
CONF-900135–		(General meeting of the Division of Particles and Fields of the American Physical Society; Houston, TX (USA); 3-6 Jan 1990)			
1	15:29460	*See* FNAL/C–90/57-T			
CONF-900140–		(SPIE optics, electro-optics and laser applications in science and engineering conference and exhibition; Los Angeles, CA (USA); 15-19 Jan 1990)			
19	15:28651	*See* UCRL-JC–103167			
20	15:29117	*See* LA-UR–90-705			
21	15:28766	*See* UCRL-JC–103338			
CONF-900181–		(18. international workshop of the gross properties of nuclei and nuclear excitations; Hirschegg (Austria); 15-20 Jan 1990)			
3	15:29547	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009316	MF-413
CONF-900186–		(1. US-Japanese workshop on combustion synthesis; Ibaraki (Japan); 11-12 Jan 1990)			
1	15:28687	*See* UCRL–102287			
CONF-900187–		(VPI conference; Blacksburg, VA (USA); 22 Jan 1990)			
1	15:28727	*See* WSRC-RP–89-1438			
CONF-900210–		(16. annual waste management symposium: working towards a cleaner environment; Tucson, AZ (USA); 25 Feb - 1 mar 1990)			
41	15:28143	*See* WSRC-MS–90-07			
42	15:27687	*See* EGG-M–90045			
43	15:29105	*See* UCRL–102790			
44	15:29106	*See* UCRL–102859			
45	15:29104	*See* UCRL–102781			
CONF-9002111–		(Proceedings, data analysis and interpretation for environmental surveillance; Lexington, KY (USA); 5-7 Feb 1990)			
1	15:27758	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009419	MF-702
CONF-9002112–		(28. winter meeting on nuclear dynamics; Bormio (Italy); Feb 1990)			
1	15:29548	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009315	MF-414
CONF-9002113–		(GISPRI symposium '90 meeting; Tokyo (Japan); 28 Feb 1990)			
1	15:28984	*See* BNL–44417			
CONF-900237–		(Conference on research trends in nonlinear and relativistic plasma physics; San Diego, CA (USA); 2-8 Feb 1990)			
1	15:29630	*See* GA-A–20024			
CONF-900255–		(Southeast regional climate symposium: global change - a southern perspective; Charleston, SC (USA); 19-22 Feb 1990)			
2	15:29028	*See* UCRL-JC–103166			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-900282–		(Annual Society of Acoustical Engineers congress; Detroit, MI (USA); 26 Feb - 2 mar 1990)			
3	15:28346	*See* UCRL–102784			
CONF-900289–		(International workshop on the polarized ion sources and polarized gas jets; Tsukuba-Shi (Japan); 12-17 Feb 1990)			
4	15:29346	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009809	MF-414
CONF-900295–		(6. workshop on nuclear dynamics; Jackson Hole, WY (USA); 17-24 Feb 1990)			
3	15:29540	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010127	MF-413
CONF-9003100–		(International workshop on cold neutron sources; Los Alamos, NM (USA); 5-8 Mar 1990)			
3	15:27786	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009808	MF-404
CONF-9003116–		(US-USSR exchange visit to Kharkov Physico-Technical Institute seminar; Experiments on the Wendelstein VII-AS and ATF stellerators seminar; US-USSR exchange visit to Institute of General Physics seminar; Kharkov (USSR); Munich (Germany, F.R.); Moscow (USSR); 19-20 Mar 1990; 26-28 mar 1990;)			
1	15:29797	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009229	MF-420
CONF-9003117–		(US-USSR exchange visit to Kharkov Physico-Technical Institute seminar; Experiments on the Wendelstein VII-AS and ATF stellerators seminar; US-USSR exchange visit to Institute of General Physics seminar; Kharkov (USSR); Munich (Germany, F.R.); Moscow (USSR); 19-20 Mar 1990; 26-28 mar 1990;)			
1	15:29797	*See* CONF-9003116–1			
CONF-9003124–		(US-USSR exchange visit to Kharkov Physico-Technical Institute seminar; Experiments on the Wendelstein VII-AS and ATF stellerators seminar; US-USSR exchange visit to Institute of General Physics seminar; Kharkov (USSR); Munich (Germany, F.R.); Moscow (USSR); 19-20 Mar 1990; 26-28 mar 1990;)			
2	15:29797	*See* CONF-9003116–1			
CONF-9003132–		(IBM 3090 supercomputing competition meeting; White Plains, NY (USA); 1 Mar 1990)			
1	15:27670	*See* WSRC-RP–89-812			
CONF-9003138–		(Sensors Expo west conference; Long Beach, CA (USA); 14 Mar 1990)			
1	15:28931	*See* EGG-M–90092			
2	15:28952	*See* EGG-M–90028			
CONF-9003139–		(Materials research center of excellence seminar; El Paso, TX (USA); 5 Mar 1990)			
1	15:28552	*See* SAND–90-0890C			
CONF-9003141–		(NWC-CMM user group conference; Golden, CO (USA); 20-21 Mar 1990)			
1	15:28712	*See* UCRL-JC–103312			
CONF-9003142–		(1990 joint government/industry symposium on insensitive munitions technology; White Oak, MD (USA); 13-14 Mar 1990)			
1	15:28968	*See* UCRL-JC–103107			
CONF-900331–		(Heavy ion physics at the alternating gradient synchrotron; Upton, NY (USA); 5-7 Mar 1990)			
1	15:29517	*See* BNL–44430			
2	15:29538	*See* BNL–44431			
3	15:29445	*See* BNL–44429			
5	15:29545	*See* BNL-NUREG–44453			
CONF-900348–		(2. international industrial symposium on the super collider; Miami, FL (USA); 14-16 Mar 1990)			
1	15:28795	*See* FNAL-TM–1653			
CONF-900391–		(1990 American Institute of Chemical Engineers (AIChE) spring meeting; Orlando, FL (USA); 18-22 Mar 1990)			
5	15:27842	*See* EGG-M–90040			

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CONF-900406–		(International conference for high-level radioactive waste management; Las Vegas, NV (USA); 8-12 Apr 1990)			
63	15:27737	*See* UCRL–102114			
67	15:27719	*See* PNL-SA–17574			
68	15:27718	*See* PNL-SA–17523			
69	15:27717	*See* PNL-SA–17402			
CONF-9004103–		(Oil shale contractors review; Morgantown, WV (USA); 18-19 Apr 1990)			
1	15:27646	*See* SAND–90-1105C			
CONF-9004125–		(8. SPIE's applications of artificial intelligence conference; Orlando, FL (USA); 17-19 Apr 1990)			
3	15:29909	*See* SAND–89-2383C			
CONF-9004134–		(Field monitoring for a purpose conference; Gothenburg (Sweden); 2-5 Apr 1990)			
2	15:28956	*See* PNL-SA–17849			
CONF-9004147–		(1990 JANNAF propulsion systems hazards meeting; Laurel, MD (USA); 3-5 Apr 1990)			
4	15:28967	*See* UCRL–102467			
CONF-9004155–		(Society of American Value Engineers international conference; Baltimore, MD (USA); Apr 1990)			
1	15:28711	*See* UCRL–102777			
CONF-9004159–		(5. distributed memory computing conference; Charleston, SC (USA); 9-12 Apr 1990)			
3	15:29581	*See* SAND–89-2918C			
CONF-9004166–		(1990 archaeometry symposium; Heidelberg (Germany, F.R.); 2-6 Apr 1990)			
1	15:28464	*See* BNL–44411			
CONF-9004168–		(American Concrete Institute spring conference; Ontario (Canada); 18-23 Apr 1990)			
1	15:27741	*See* WHC-SA–0560			
CONF-9004169–		(26. engineering geology symposium; Pocatello, ID (USA); 4-6 Apr 1990)			
1	15:27684	*See* EGG-M–89477			
2	15:27686	*See* EGG-M–90030			
CONF-9004171–		(International conference of jointed and faulted rock; Vienna (Austria); 18-20 Apr 1990)			
1	15:27725	*See* SAND–89-1765C			
2	15:27724	*See* SAND–89-1441C			
CONF-9004173–		(DOE real-time subsurface monitoring of groundwater workshop; Dallas, TX (USA); 17-18 Apr 1990)			
1	15:29065	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009822	MF-402
2	15:28928	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009420	MF-406; MF-402
CONF-9004174–		(VLSI test symposium; Atlantic City, NJ (USA); 10-11 Apr 1990)			
1	15:28551	*See* SAND–90-0613C			
CONF-9004176–		(ETS/TES 1990 conference on thermal storage; Washington, DC (USA); 10 Apr 1990)			
1	15:28104	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009862	MF-202
CONF-9004177–		(Advanced computing for the social sciences conference; Williamsburg, VA (USA); 10-12 Apr 1990)			
1	15:29848	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009825	MF-405
CONF-9004178–		(Vision-21 space travel for the next millenium; Cleveland, OH (USA); 3-4 Apr 1990)			
1	15:28034	*See* BNL–44443			
CONF-9004179–		(Cray users group conference; Toronto (Canada); Apr 1990)			
1	15:29916	*See* UCRL-JC–103143			
CONF-900419–		(8. international triennial conference on thin films and the 17th international conference on metallurgical coatings; San Diego, CA (USA); 1-6 Apr 1990)			
4	15:28531	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010115	MF-373
CONF-900438–		(Workshop on statistics of human exposure to ionizing radiation; Oxford (UK); 2-4 Apr 1990)			
1	15:29182	*See* PNL-SA–17384-HEDR			

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CONF-900450–		(Nuclear structure in the '90's; Oak Ridge, TN (USA); 23-27 Apr 1990)			
2	15:29539	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010103	MF-413
CONF-900466–		(Spring meeting of the Materials Research Society; San Francisco, CA (USA); 16-21 Apr 1990)			
4	15:28650	*See* SAND–90-0818C			
5	15:28386	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009812	MF-404
6	15:28387	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009858	MF-404
7	15:28532	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009856	MF-404
8	15:29575	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009864	MF-423
10	15:28388	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010112	MF-404
15	15:29347	NTIS, PC A02/MF A01; OSTI; INIS		DE90010148	MF-411
CONF-9005106–		(13. Department of Energy computer security group conference: security through teamwork; Augusta, GA (USA); 8-10 May 1990)			
	15:29849	NTIS, PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010251	MF-700
CONF-9005117–		(GEOVAL '90; Stockholm (Sweden); 14-17 May 1990)			
5	15:27732	*See* SAND–89-2359C			
CONF-9005149–		(4. national outdoor action conference; Las Vegas, NV (USA); 14-17 May 1990)			
3	15:27685	*See* EGG-M–89491			
CONF-9005150–		(Ionospheric effects symposium; Washington, DC (USA); 1-3 May 1990)			
1	15:29340	*See* LA-UR–90-906			
CONF-9005155–		(DOD conference on industry advanced coatings removal; Atlanta, GA (USA); 1-3 May 1990)			
1	15:28698	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009429	
CONF-9005156–		(Millipore 1990 microelectronics technical symposium; Santa Clara, CA (USA); 21 May 1990)			
1	15:28708	*See* SAND–90-0223C			
CONF-9005157–		(Methods and equipment of metrology equipment; Milwaukee, WI (USA); 7-9 May 1990)			
1	15:28959	*See* SAND–90-0906C			
CONF-9005158–		(1990 AT&T conference on electronic testing; Princeton, NJ (USA); -10 May 1990)			
1	15:28550	*See* SAND–90-0608C			
CONF-9005159–		(7. HMCRI's national RCRA/superfund conference and exhibition; St. Louis, MO (USA); 2-4 May 1990)			
1	15:27658	*See* FMPC–2190			
CONF-900557–		(8. topical conference on high-temperature plasma diagnostics; Hyannis, MA (USA); 6-10 May 1990)			
1	15:29623	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010434	MF-426
CONF-900580–		(1990 Digital Equipment Corporation User's Society meeting; New Orleans, LA (USA); 7-11 May 1990)			
4	15:29933	*See* SAND–89-2813C			
CONF-900599–		(36. ISA international instrumentation symposium; Denver, CO (USA); 6-10 May 1990)			
5	15:28943	*See* BNL-NUREG–44386			
CONF-900602–		(17. European conference on controlled fusion and plasma heating; Amsterdam (Netherlands); 25-29 Jun 1990)			
1	15:29624	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009810	MF-421
2	15:29794	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009827	MF-421
3	15:29625	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009826	MF-421
4	15:29795	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009818	MF-420
5	15:29626	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009859	MF-420
6	15:29631	*See* GA-A–20031			
CONF-900607–		(Advances in human factors research on man-computer interactions: nuclear and beyond; Nashville, TN (USA); 10-15 Jun 1990)			
1	15:28005	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005661	MF-530
2	15:27971	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006887	MF-520
3	15:27782	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007052	MF-505
4	15:28042	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007047	MF-506

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CONF-900608–		(American Nuclear Society annual meeting; Nashville, TN (USA); 10-15 Jun 1990)			
1	15:28060	*See* K/CSD/INF–89/40			
2	15:29541	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90004303	MF-413
3	15:28032	*See* WSRC-RP–89-1270			
4	15:29170	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005273	
5	15:28022	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005454	MF-404
6	15:29542	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005675	MF-413
7	15:28707	*See* SAND–90-0099C			
8	15:29568	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006562	MF-401
10	15:28696	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006892	MF-406
11	15:27675	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008407	MF-406; MF-405
12	15:28043	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008408	MF-506
13	15:27988	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008752	MF-505
14	15:28033	*See* WSRC-RP–89-1380			
9-Rev.	15:29570	*See* LA-UR–90-97-Rev.			
CONF-9006101–		(ACM SIGPLAN '90: conference on programming language design and implementation; White Plains, NY (USA); 20 Jun 1990)			
1-Rev.1	15:29914	*See* UCRL–102263-Rev.1			
CONF-9006107–		(Symposium on numerical methods for multiphase flows; Toronto (Canada); 3-9 Jun 1990)			
1	15:27423	*See* DOE/PC/79935–13			
2	15:28054	*See* EGG-M–89359			
CONF-9006111–		(5. conference on mountain meteorology; Boulder, CO (USA); 26-29 Jun 1990)			
1	15:28996	*See* LA-UR–90-53			
2	15:27696	*See* LA-UR–90-720			
3	15:29268	*See* LA-UR–90-721			
CONF-9006115–		(American Nuclear Society topical meeting on human factors; Snowbird, UT (USA); 10-14 Jun 1990)			
1	15:28006	*See* EGG-M–89492			
CONF-9006117–		(Annual meeting of The American Society of Heating, Refrigerating and Air-Conditioning Engineers; St. Louis, MO (USA); 9-13 Jun 1990)			
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CONF-9006120–		(International symposium on unique underground structures; Denver, CO (USA); 12-15 Jun 1990)			
1	15:27695	*See* LA-UR–90-638			
CONF-9006121–		(4. international SAMPE electronic materials and processes conference; Albuquerque, NM (USA); 12-14 Jun 1990)			
1	15:28761	*See* SAND–89-2730C			
2	15:28760	*See* SAND–89-2617C			
3	15:28751	*See* KCP–613-4303			
4	15:28491	*See* LA-UR–90-756			
5	15:28492	*See* LA-UR–90-933			
CONF-9006122–		(International conference on micromechanics of failure of quasi-brittle materials; Albuquerque, NM (USA); 7-8 Jun 1990)			
1	15:28549	*See* SAND–90-0541C			
2	15:28548	*See* SAND–90-0507C			
3	15:28731	*See* SAND–90-0534C			
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CONF-9006123–		(USENIX conference proceedings; Anaheim, CA (USA); 11-18 Jun 1990)			
1	15:29915	*See* UCRL–102872			
CONF-9006124–		(Society for Experimental Mechanics conference; Albuquerque, NM (USA); 4-6 Jun 1990)			
1	15:28954	*See* KCP–613-4302			
2	15:29908	*See* SAND–89-2244C			
3	15:28488	*See* EGG-M–90043			

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CONF-900613–		(International conference on fast reactor core and fuel structural behavior; Inverness (UK); 4-6 Jun 1990)			
1	15:28028	*See* WHC-SA–0683			
CONF-9006132–		(Annual international industrial ergonomics and safety conference; Montreal (Canada); 10-13 Jun 1990)			
1	15:28102	*See* UCRL–102857			
CONF-9006135–		(1990 IEEE international symposium on electrical insulation; Toronto (Canada); 3-6 Jun 1990)			
1	15:28534	NTIS, PC A03/MF A01 - OSTI		DE90008571	MF-220
CONF-9006136–		(International conference on neural networks; San Diego, CA (USA); 17-21 Jun 1990)			
1	15:29934	*See* UCRL–102749			
CONF-9006137–		(Nonlinear dynamics in optical systems topical meeting; Afton, OK (USA); 4-8 Jun 1990)			
1	15:29602	*See* UCRL–102992			
CONF-9006146–		(34. international power sources symposium; Cherry Hill, NJ (USA); 25-28 Jun 1990)			
1	15:28113	*See* SAND–89-2567C			
2	15:28112	*See* SAND–89-2313C			
3	15:28970	*See* SAND–89-2382C			
CONF-9006149–		(1. United States - Japan symposium on advances in welding metallurgy; San Francisco, CA (USA); 7-8 Jun 1990)			
1	15:28390	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008908	MF-404
2	15:29798	*See* CONF-9006162–2			
CONF-900615–		(35. international gas turbine and aeroengine congress and exposition (TURBO Expo); Brussels (Belgium); 11-14 Jun 1990)			
1	15:27575	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005664	MF-125
2	15:28343	*See* LA-UR–89-4275			
CONF-9006155–		(ASME fluid measurements and instrumentation conference; Toronto (Canada); 4-7 Jun 1990)			
1	15:28958	*See* SAND–90-0050C			
CONF-9006156–		(8. international conference on computational methods in water resources; Venice (Italy); 11-15 Jun 1990)			
1	15:29103	*See* UCRL–102124			
2	15:29379	*See* UCRL-JC–103270			
CONF-9006162–		(1. U.S.-Japan symposium on advances in welding metallurgy; Yokohama (Japan); 12-13 Jun 1990)			
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2	15:29798	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009820	MF-423
CONF-9006164–		(7. international conference on testing computer software; San Francisco, CA (USA); 21 Jun 1990)			
1	15:29913	*See* UCRL–102052			
CONF-9006165–		(U.S. army science conference; Durham, NC (USA); 12-15 Jun 1990)			
1	15:28963	NTIS, PC A03/MF A01 - OSTI		DE90009860	
CONF-9006167–		(Japan/USA symposium; Palo Alto, CA (USA); 5-7 Jun 1990)			
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CONF-900617–		(Pressure vessels and piping conference: be in tune for the 90's; Nashville, TN (USA); 17-21 Jun 1990)			
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4	15:28029	*See* WHC-SA–0741			
5	15:28041	*See* BNL-NUREG–44323			
6	15:28075	*See* SAND–89-2505C			
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9	15:27962	*See* BNL-NUREG–44440			
CONF-900619–		(5. AIPA/ASME thermophysics and heat transfer conference; Seattle, WA (USA); 18-20 Jun 1990)			
1	15:28759	*See* SAND–89-2425C			

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2	15:27727	*See* SAND–89-2175C			
3	15:27531	*See* SAND–89-2314C			
CONF-900623–		(15. symposium on effects of radiation on materials; Nashville, TN (USA); 17-21 Jun 1990)			
1	15:29814	*See* WHC-SA–0693			
2	15:28027	*See* WHC-SA–0475			
3	15:29796	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009811	MF-423
CONF-900628–		(17. international conference for the electric power industry: reliability, availability, maintainability strategies for the 90's; Hershey, PA (USA); 12-15 Jun 1990)			
1	15:28192	*See* EGG-M–89411			
CONF-900640–		(International conference on rock joints; Loen (Norway); 4-6 Jun 1990)			
1	15:27731	*See* SAND–89-2347C			
2	15:27733	*See* SAND–89-2446C			
3	15:27875	*See* LA-UR–90-505			
4	15:27529	*See* LBL–28442			
4	15:27697	*See* LBL–28444			
5	15:29269	*See* LBL–28600			
CONF-900646–		(31. US symposium on rock mechanics; Golden, CO (USA); 18-20 Jun 1990)			
1	15:27728	*See* SAND–89-2268C			
2	15:27730	*See* SAND–89-2322			
3	15:29277	*See* SAND–89-2913C			
4	15:27729	*See* SAND–89-2282C			
5	15:29276	*See* SAND–89-2126C			
6	15:28554	*See* UCRL–102603			
7	15:29267	*See* LA-UR–90-99			
8	15:29266	*See* LA-UR–90-51			
9	15:27726	*See* SAND–89-2146C			
10	15:29278	*See* UCRL–101526			
11	15:27530	*See* LBL–28443			
CONF-900651–		(International symposium on nonsteady fluid dynamics; Toronto (Canada); 4-7 Jun 1990)			
1	15:29376	*See* SAND–89-1927C			
2	15:28718	*See* LA-UR–90-857			
3	15:28717	*See* LA-UR–90-856			
CONF-900652–		(10. international conference on pattern recognition; Atlantic City, NJ (USA); 17-21 Jun 1990)			
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CONF-900672–		(16. AIAA aerodynamic ground testing conference; Seattle, WA (USA); 18-20 Jun 1990)			
1	15:28705	*See* SAND–89-2666C			
CONF-900673–		(5. North American masonry conference; Urbana, IL (USA); 3-6 Jun 1990)			
1	15:28248	*See* K/D–5834			
CONF-900676–		(83. annual meeting and exhibition of the Air and Waste Management Association; Pittsburgh, PA (USA); 24-29 Jun 1990)			
1	15:28989	*See* EGG–10617-4101			
2	15:27742	*See* WHC-SA–0891			
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CONF-900679–		(1990 Health Physics Society meeting; Anaheim, CA (USA); 24-28 Jun 1990)			
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CONF-900684–		(5. international colloquium on free boundary problems: theory and applications; Montreal (Canada); 13-22 Jun 1990)			
1	15:29378	*See* UCRL-JC–103243			
2	15:29576	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009398	MF-405
1-Rev.1	15:28726	*See* UCRL-JC–103243-Rev.1			
CONF-900689–		(Conference on precision electromagnetic measurements; Ottawa (Canada); 11-14 Jun 1990)			
1	15:28762	*See* SAND–90-0081C			
2	15:28706	*See* SAND–89-3134C			
CONF-900690–		(34. annual meeting of the American Association of Cost Engineers; Boston, MA (USA); 24-27 Jun 1990)			
1	15:27676	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90005265	MF-402

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89/0311	15:28169	*See* PB–90-164377/XAB			
89/0312	15:27589	*See* PB–90-162199/XAB			
90009778	15:27610	OSTI; Gas Research Institute, 8600 West Bryn Mawr Avenue, Chicago, IL 60631		TI90009778	
GRS–					
75	15:29045	NTIS (US Sales Only), PC A04/MF A01		DE90773669	
GRS-A–					
1557	15:28037	*See* BMU–1989-[illegible]			
1602	15:28039	*See* BMU–19[illegible]			
GRS-F–					
174	15:28057	NTIS (US Sales Only), PC A09/MF A01		DE90780230	
GSF–					
6/89	15:29198	NTIS (US Sales Only), PC A22/MF A01		DE90773485	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
GSI–					
88-20	15:28850	NTIS (US Sales Only), PC A03/MF A01		DE90780365	
HEPHY-PUB–					
525/89	15:29599	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623358	
HEPHY/PUB–					
527	15:29461	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623708	
HETA–					
88-156-1984	15:29241	*See* PB–90-161852/XAB			
89-142-1981	15:29007	*See* PB–90-161845/XAB			
89-155-1979	15:29006	*See* PB–90-161837/XAB			
HNEI–					
90-1002	15:28287	OSTI; Hawaii Natural Energy Institute, University of Hawaii at Manoa, 2540 Dole Street, Holmes Hall 246, Honolulu, HI 96822		TI90009934	
IABG-B-TF–					
1753	15:28038	*See* BMU–1989-234			
IBP-WB–					
18/1987	15:28235	Copy held by UB/TIB Hannover			
20/1987	15:28236	Copy held by UB/TIB Hannover			
21/1987	15:28237	Copy held by UB/TIB Hannover			
22/1987	15:28238	Copy held by UB/TIB Hannover			
24/1988	15:28239	Copy held by UB/TIB Hannover			
25/1988	15:28240	Copy held by UB/TIB Hannover			
26/1988	15:28241	Copy held by UB/TIB Hannover			
28/1988	15:28242	Copy held by UB/TIB Hannover			
29/1988	15:28243	Copy held by UB/TIB Hannover			
30/1988	15:28244	Copy held by UB/TIB Hannover			
31/1988	15:28245	Copy held by UB/TIB Hannover			
32/1988	15:28246	Copy held by UB/TIB Hannover			
37/1988	15:27864	Copy held by UB/TIB Hannover			
38/1988	15:27865	Copy held by UB/TIB Hannover			
46/1989	15:27866	Copy held by UB/TIB Hannover			
ICASE–					
90-10	15:29601	*See* N–90-16401			
IEACR–					
20	15:27509	IEA Coal Research, Gemini House, 10-18 Putney Hill, London SW15 6AA, United Kingdom			PC-101; ND-101
21	15:27494	IEA Coal Research, Gemini House, 10-18 Putney Hill, London SW15 6AA, United Kingdom			PC-103; ND-103
IEPA/LPC–					
89/902	15:29098	*See* PB–90-164930/XAB			
IFP–					
37-451	15:27843	NTIS (US Sales Only), PC A06/MF A01		DE90773308	
IFSR–					
424	15:29628	*See* DOE/ET/53088–424			
426	15:29629	*See* DOE/ET/53088–426			
IKE–					
4-128	15:28983	*See* BMU–1988-236			
7-14	15:28247	NTIS (US Sales Only), PC A12/MF A01		DE90780120	
8-20	15:28118	NTIS (US Sales Only), PC A09/MF A01		DE90773533	
8-21	15:28119	NTIS (US Sales Only), PC A08/MF A01		DE90780121	
INDC(JPN)–					
136/L	15:29507	*See* JAERI-M–90-025			
INIS-SU–					
162	15:28600	NTIS (US Sales Only), PC A99/MF A01; OSTI; INIS		DE90706081	
164	15:29175	NTIS (US Sales Only), PC A12/MF A01; OSTI; INIS		DE90706080	
166	15:29506	NTIS (US Sales Only), PC A99/MF A01; OSTI; INIS		DE90706082	
INIS-XN–					
199	15:29850	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90625258	
INP–					
1345/AP	15:29569	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623767	
INS–					
783	15:29490	NTIS (US Sales Only), PC A03/MF A01		DE90777708	
785	15:29462	NTIS (US Sales Only), PC A02/MF A01		DE90777709	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
787	15:29543	NTIS (US Sales Only), PC A03/MF A01		DE90777710	
788	15:29491	NTIS (US Sales Only), PC A03/MF A01		DE90777711	
789	15:29463	NTIS (US Sales Only), PC A03/MF A01		DE90777712	
791	15:29464	NTIS (US Sales Only), PC A03/MF A01		DE90777713	
795	15:29492	NTIS (US Sales Only), PC A03/MF A01		DE90777714	
796	15:29465	NTIS (US Sales Only), PC A02/MF A01		DE90777715	
INS-T–					
486	15:28851	NTIS (US Sales Only), PC A05/MF A01		DE90777883	
IPP–					
III/139	15:29653	NTIS (US Sales Only), PC A07/MF A01		DE90780658	
IPPCZ–					
284	15:29632	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623583	
285	15:29633	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623584	
286	15:29634	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623585	
287	15:29635	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623586	
289	15:29636	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623587	
290	15:29637	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623632	
291	15:29638	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623633	
292	15:29639	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623588	
293/I	15:29622	NTIS (US Sales Only), PC A08/MF A01; OSTI; INIS		DE90623578	
IRAP–					
89622	15:27872	*See* STEV-GT–89-2			
ISH–					
130	15:28678	Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene			
ISTC-PU–					
3040	15:28124	PC Canada Dept. of Regional Industrial Expansion, Library (CEIB), 235 Queen St., Ottawa, ON, CAN K1A 0H5; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
IVO-A–					
10/89	15:28700	NTIS (US Sales Only), PC A04/MF A01		DE90770763	
IWS–					
146.17	15:29239	*See* PB–90-155938/XAB			
146.22	15:29008	*See* PB–90-162447/XAB			
J–					
550-90-601/2454	15:29662	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009213	MF-406
JAERI-M–					
89-136	15:28024	NTIS (US Sales Only), PC A09/MF A01		DE90777748	
89-160	15:28031	NTIS (US Sales Only), PC A13/MF A01		DE90777716	
89-179	15:28058	NTIS (US Sales Only), PC A03/MF A01		DE90777736	
89-185	15:27659	NTIS (US Sales Only), PC A03/MF A01		DE90777746	
89-186	15:28003	NTIS (US Sales Only), PC A06/MF A01		DE90777737	
89-187	15:28729	NTIS (US Sales Only), PC A04/MF A01		DE90777738	
89-188	15:27667	NTIS (US Sales Only), PC A03/MF A01		DE90777747	
89-190	15:29893	NTIS (US Sales Only), PC A04/MF A01		DE90777717	
89-192	15:27759	NTIS (US Sales Only), PC A05/MF A01		DE90777740	
89-193	15:29802	NTIS (US Sales Only), PC A03/MF A01		DE90777749	
89-194	15:28025	NTIS (US Sales Only), PC A03/MF A01		DE90777718	
89-195	15:28008	NTIS (US Sales Only), PC A05/MF A01		DE90777719	
89-196	15:28893	NTIS (US Sales Only), PC A03/MF A01		DE90777733	
89-197	15:29166	NTIS (US Sales Only), PC A03/MF A01		DE90777721	
89-198	15:28026	NTIS (US Sales Only), PC A03/MF A01		DE90777720	
89-199	15:28004	NTIS (US Sales Only), PC A03/MF A01		DE90777739	
89-200	15:27691	NTIS (US Sales Only), PC A03/MF A01		DE90777750	
89-201	15:27992	NTIS (US Sales Only), PC A08/MF A01		DE90777734	
89-202	15:29803	NTIS (US Sales Only), PC A06/MF A01		DE90777741	
89-203	15:28536	NTIS (US Sales Only), PC A03/MF A01		DE90777751	
89-205	15:28953	NTIS (US Sales Only), PC A05/MF A01		DE90777742	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
JAERI-M–					
89-207	15:28920	NTIS (US Sales Only), PC A07/MF A01		DE90777752	
89-208	15:28059	NTIS (US Sales Only), PC A15/MF A01		DE90777753	
89-209	15:29663	NTIS (US Sales Only), PC A03/MF A01		DE90777743	
89-210	15:28398	NTIS (US Sales Only), PC A04/MF A01		DE90777754	
89-211	15:27692	NTIS (US Sales Only), PC A03/MF A01		DE90777744	
89-216	15:27973	NTIS (US Sales Only), PC A03/MF A01		DE90777755	
89-217	15:29664	NTIS (US Sales Only), PC A03/MF A01		DE90777756	
89-218	15:28701	NTIS (US Sales Only), PC A04/MF A01		DE90777757	
89-219	15:28702	NTIS (US Sales Only), PC A03/MF A01		DE90777758	
90-025	15:29507	Japan Atomic Energy Research Institute, Department of Technical Information, Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan			
JAI–					
315	15:27705	*See* ORNL/Sub–86-SA094/4			
322	15:27707	*See* ORNL/Sub–86-SA094/7			
325	15:27706	*See* ORNL/Sub–86-SA094/5			
328	15:27708	*See* ORNL/Sub–86-SA094/8			
JINR–					
D13-89-548	15:28894	NTIS (US Sales Only), PC A03/MF A01; OSTI; JINR, Publishing Dept., Head Post Office, P.O. Box 79 101000, Moscow, USSR		DE90009782	
D13-89-549	15:28895	NTIS (US Sales Only), PC A03/MF A01; OSTI; JINR, Publishing Dept., Head Post Office, P.O. Box 79 101000, Mowcow, USSR		DE90009785	
D13-89-550	15:28896	NTIS (US Sales Only), PC A03/MF A01; OSTI; JINR, Publishing Dept., Head Post Office, P.O. Box 79 101000, Moscow, USSR		DE90009786	
E11-89-442	15:29600	NTIS (US Sales Only), PC A03/MF A01; OSTI; JINR, Publishing Dept., Head Post Office, P.O. Box 79 101000, Moscow, USSR		DE90009784	
E6-89-725	15:29265	NTIS (US Sales Only), PC A03/MF A01; OSTI; JINR, Publishing Dept., Head Post Office, P.O. Box 79101000, Moscow, USSR		DE90009783	
Juel–					
2267	15:28342	NTIS (US Sales Only), PC A06/MF A01		DE90779852	
2313	15:27528	NTIS (US Sales Only), PC A14/MF A01		DE90780271	
2326	15:29229	NTIS (US Sales Only), PC A06/MF A01		DE90773652	
2335	15:28995	NTIS (US Sales Only), PC A04/MF A01		DE90773655	
Juel-Spez–					
519	15:28897	NTIS (US Sales Only), PC A05/MF A01		DE90773574	
526	15:29466	NTIS (US Sales Only), PC A05/MF A01		DE90780369	
527	15:29467	NTIS (US Sales Only), PC A07/MF A01		DE90780368	
545	15:29046	NTIS (US Sales Only), PC A24/MF A01		DE90780411	
K/CSD/INF–					
89/40	15:28060	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90004148	MF-523
K/D–					
5834	15:28248	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90003518	MF-506
KAERI/RR–					
720/88/ST1	15:27693	NTIS (US Sales Only), PC A10/MF A01; OSTI; INIS		DE90624467	
764/88	15:29665	NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS		DE90623624	
KCP–					
613-4302	15:28954	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008312	MF-706
613-4303	15:28751	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008313	MF-704
KEK–					
89-3	15:29894	NTIS (US Sales Only), PC A14/MF A01		DE90777889	
89-7	15:29446	NTIS (US Sales Only), PC A11/MF A01		DE90777890	
89-12	15:29508	NTIS (US Sales Only), PC A11/MF A01		DE90777829	
89-15	15:29521	NTIS (US Sales Only), PC A03/MF A01		DE90777759	
89-17	15:29447	NTIS (US Sales Only), PC A12/MF A01		DE90777869	
KFK–					
3908	15:29176	NTIS (US Sales Only), PC A04/MF A01		DE90780366	
4157	15:27783	NTIS (US Sales Only), PC A05/MF A01		DE90780227	
4514	15:29230	NTIS (US Sales Only), PC A07/MF A01		DE90773642	
4642	15:27694	NTIS (US Sales Only), PC A06/MF A01		DE90773546	
4645	15:28061	NTIS (US Sales Only), PC A05/MF A01		DE90773723	
4652	15:28908	NTIS (US Sales Only), PC A06/MF A01		DE90780246	
4655	15:29549	NTIS (US Sales Only), PC A03/MF A01		DE90780367	
4667	15:27668	NTIS (US Sales Only), PC A03/MF A01		DE90773724	
4677	15:29804	NTIS (US Sales Only), PC A06/MF A01		DE90780228	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
4678	15:27655	NTIS (US Sales Only), PC A03/MF A01		DE90773575	
KIB-RUB-TWM–					
85-6	15:28735	Bochum Univ. (Germany, F.R.). Inst. fuer Konstruktiven Ingenieurbau			
KTM/E-D–					
179	15:27942	NTIS (US Sales Only), PC A04/MF A01		DE90770712	
180	15:28249	NTIS (US Sales Only), PC A07/MF A01		DE90770760	
KURRI-TR–					
327	15:28000	NTIS (US Sales Only), PC A08/MF A01		DE90777871	
KVL-JI-MEDD–					
61	15:27803	NTIS (US Sales Only), PC A05/MF A01		DE90770685	
LA–					
10639-MS	15:28062	NTIS, PC A21/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009219	
11684-C-Vol.1	15:28796	NTIS, PC A20/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010235	MF-414
11684-C-Vol.2	15:28797	NTIS, PC A20/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010237	MF-414
11716-MS	15:28974	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009758	PC-700
11752-MS	15:28975	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009759	PC-700
1721-5th-Ed.	15:28601	NTIS, PC A14/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010156	MF-701; MF-703
224/89	15:29179	*See* OEFZS–4515			
LA-UR–					
89-4275	15:28343	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90004874	
90-505	15:27875	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007537	MF-251
90-51	15:29266	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008460	MF-802
90-53	15:28996	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009043	MF-403
90-638	15:27695	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007495	MF-814
90-705	15:29117	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008992	
90-720	15:27696	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008991	MF-402
90-721	15:29268	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008965	
90-756	15:28491	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008949	MF-332
90-856	15:28717	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008940	MF-906
90-857	15:28718	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008939	MF-906
90-906	15:29340	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008931	MF-705; MF-706
90-933	15:28492	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008928	MF-332
90-97-Rev.	15:29570	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90006479	MF-905
90-99	15:29267	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006481	MF-703
LBL–					
28442	15:27529	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009191	MF-403; MF-802
28443	15:27530	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009193	MF-406; MF-402
28444	15:27697	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009202	MF-810
28600	15:29269	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009222	MF-403
LBL-PUB–					
625-Vol.16	15:28157	Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720			ND-400
625-Vol.17	15:28158	Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720			ND-400
625-Vol.18	15:28159	Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720			ND-400
625-Vol.19	15:28160	Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720			ND-400
625-Vol.21	15:28161	Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720			ND-400
625-Vol.22	15:28162	Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720			ND-400
625-Vol.23	15:28163	Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720			ND-400
625-Vol.24	15:28164	Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720			ND-400
625-Vol.25	15:28165	Glenn T. Seaborg, Lawrence Berkeley Laboratory, Mail Stop 70-A-3307, 1 Cyclotron Road, Berkeley, CA 94720			ND-400

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LHC-Note–					
94	15:28910	*See* NIKHEF-H–89-12			
LIS–					
88	15:27834	Copy held by UB/TIB Hannover			
LNCC–					
019/89	15:28719	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624851	
028/89	15:28720	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624852	
029/89	15:28721	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624853	
LPNHE–					
89-04	15:28909	NTIS (US Sales Only), PC A03/MF A01		DE90770336	
LRP–					
305/86	15:29666	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623594	
348/88	15:29667	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90620691	
349/88	15:29668	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90623595	
391/89	15:29669	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623596	
395/90	15:29670	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623616	
LUTFD2-TFKF–					
1015-1-139-1989	15:28602	NTIS (US Sales Only), PC A07/MF A01		DE90770802	
LUTMDN-TMVK–					
5179-1-120-1989	15:28352	NTIS (US Sales Only), PC A06/MF A01		DE90770865	
5183-1-94-1989	15:27898	NTIS (US Sales Only), PC A05/MF A01		DE90770864	
5184-1-147-1989	15:27899	NTIS (US Sales Only), PC A07/MF A01		DE90770877	
LYCEN–					
89-06	15:29349	NTIS (US Sales Only), PC A03/MF A01		DE90770342	
MEA–					
2376	15:28001	*See* NUREG/CR–5493			
2377	15:28002	*See* NUREG/CR–5494			
MHD–					
III-89-002	15:28216	*See* DOE/PC/70508–T4			
MICROLOG–					
90-00498	15:28124	*See* ISTC-PU–3040			
90-00948	15:28360	*See* SC/ORC–AF88-05			
MISC–					
89133	15:28046	*See* DOE/ID–10258			
MIT/LCS/TR–					
464	15:29859	*See* AD-A–216579/3/XAB			
MLM–					
3631	15:28543	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008194	PC-704
MLM-MU–					
90-64-0003	15:28752	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009968	MF-706
MPI-PAE/Exp.El.–					
196	15:29469	NTIS (US Sales Only), PC A03/MF A01		DE90780364	
MRI–					
8862-A	15:29231	*See* PB–90-132564/XAB			
MSP–					
89-3	15:29857	*See* AD-A–216433/3/XAB			
MTR–					
87W00230-VOL-1	15:28977	*See* AD-A–216734/4/XAB			
87W00230-VOL-2	15:28978	*See* AD-A–216735/1/XAB			
90W00013	15:27986	*See* NUREG/CP–0108			
N–					
90-15211	15:28402	NTIS, PC A03/MF A01			
90-15363	15:28703	NTIS, PC A04/MF A01			
90-15545	15:28955	NTIS, PC A03/MF A01			
90-15766	15:28544	NTIS, PC A04/MF A01			
90-15836	15:27787	NTIS, PC A09/MF A02			
90-16053	15:28403	NTIS, PC A03/MF A01			
90-16072	15:28493	NTIS, PC A03/MF A01			
90-16401	15:29601	NTIS, PC A03/MF A01			
90-16482	15:29350	NTIS, PC A03/MF A01			
90-16483	15:29351	NTIS, PC A03/MF A01			
90-16596	15:29283	NTIS, PC A07/MF A01			
90-16676	15:29328	NTIS, PC A02/MF A01			

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NAC-AR–					
86-01	15:28792	NTIS (US Sales Only), PC A13/MF A01; OSTI; INIS		DE90624865	
NAGRA-NTB–					
84-20	15:27698	Nagra, CH-5401 Baden, Switzerland			
84-20	15:29270	Nagra, CH-5401 Baden, Switzerland			
85-10	15:29271	Nagra, CH-5401 Baden, Switzerland			
85-10	15:29272	Nagra, CH-5401 Baden, Switzerland			
88-02E	15:28405	Nagra, CH-5401 Baden, Switzerland			
88-14	15:29273	Nagra, CH-5401 Baden, Switzerland			
88-22	15:28545	Nagra, CH-5401 Baden, Switzerland			
88-31	15:29274	Nagra, CH-5401 Baden, Switzerland			
89-07	15:29275	Nagra, CH-5401 Baden, Switzerland			
89-24	15:29047	Nagra, CH-5401 Baden, Switzerland			
NAS–					
1.15:100776	15:29283	*See* N–90-16596			
1.15:101652	15:27787	*See* N–90-15836			
1.15:101931	15:29351	*See* N–90-16483			
1.15:102495	15:28403	*See* N–90-16053			
1.15:4091-VOL-1	15:28955	*See* N–90-15545			
1.26:181984	15:29601	*See* N–90-16401			
1.26:186038	15:29328	*See* N–90-16676			
1.26:186201	15:29350	*See* N–90-16482			
1.26:186204	15:28544	*See* N–90-15766			
1.26:186205	15:28703	*See* N–90-15363			
1.26:4271	15:28493	*See* N–90-16072			
1.60:2967	15:28402	*See* N–90-15211			
NASA-CR–					
181984	15:29601	*See* N–90-16401			
186038	15:29328	*See* N–90-16676			
186201	15:29350	*See* N–90-16482			
186204	15:28544	*See* N–90-15766			
186205	15:28703	*See* N–90-15363			
4271	15:28493	*See* N–90-16072			
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100776	15:29283	*See* N–90-16596			
101652	15:27787	*See* N–90-15836			
101931	15:29351	*See* N–90-16483			
102495	15:28403	*See* N–90-16053			
4091-VOL-1	15:28955	*See* N–90-15545			
NASA-TP–					
2967	15:28402	*See* N–90-15211			
NBES–					
101	15:28250	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
2067	15:27796	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
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89-62	15:29493	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623403	
NBL–					
322	15:27784	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009545	MF-700
NBU/FF–					
2023	15:27797	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
NCRP–					
106	15:29178	National Council on Radiation Protection and Measurements Publications, 7910 Woodmont Avenue, Suite 800, Bethesda, MD 20814			
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1173(S)(pt.1)	15:28063	NTIS (US Sales Only), PC A05/MF A01; OSTI; INIS		DE90624993	
1173(S)(pt.5)	15:28064	NTIS (US Sales Only), PC A07/MF A01; OSTI; INIS		DE90624994	

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1173(S)(pt.7)	15:28065	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90624995	
NDP–					
022/R1	15:28997	*See* ORNL/CDIAC–31			
NEACRP-L–					
306	15:27993	*See* ORNL/M–1120			
NEANDC(J)–					
149/U	15:29507	*See* JAERI-M–90-025			
NEI-FI–					
89	15:27470	NTIS (US Sales Only), PC A07/MF A01		DE90770713	
90	15:27894			DE90706084	
93	15:28150	NTIS (US Sales Only), PC A03/MF A01		DE90770720	
NEI-SE–					
50	15:27471	NTIS (US Sales Only), PC A05/MF A01		DE90770840	
53	15:27510	NTIS (US Sales Only), PC A03/MF A01		DE90770795	
NERDDP-EG–					
88-702	15:27515	Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia			
88-739	15:27467	Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia			
88-740	15:27472	Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia			
88-742	15:27473	Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia			
88-749	15:27474	Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia			
88-750	15:27388	Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia			
88-751	15:27427	Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia			
88-758	15:27475	Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia			
88-759	15:27484	Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia			
88-760	15:27485	Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia			
88-763	15:27495	Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia			
88-769	15:27476	Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia			
88-770	15:27477	Department of Resources and Energy, GPO Box 858, Canberra, ACT 2601, Australia			
NIKHEF-H–					
89-5	15:29471	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623689	
89-12	15:28910	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90625158	
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470	15:27577	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009530	MF-125
NISTIR–					
89/4079	15:28546	*See* PB–90-163254/XAB			
89/4148	15:28495	*See* PB–90-163981/XAB			
NKS–					
1989-9	15:27771	Available on loan from Risoe Library, DK-4000 Roskilde			
NOSC/TD–					
1682	15:29063	*See* AD-A–216501/7/XAB			
NRL-MR–					
6391	15:29336	*See* AD-A–216626/2/XAB			
6534	15:28460	*See* AD-A–216695/7/XAB			
NRL-R–					
3034(W)	15:27972	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90625089	
NTU-CL/TRS–					
255	15:29904	*See* PB–90-168303/XAB			
NUREG–					
0020-Vol.14-No.2	15:27953	NTIS, PC A22/MF A01 - GPO - OSTI		TI90009548	
0090-Vol.12-No.4	15:27979	NTIS, PC A03/MF A01 - GPO - OSTI		TI90009757	
0304-Vol.14-No.4	15:27980	NTIS, PC A07/MF A01 - GPO - OSTI		TI90009328	
0325-Rev.13	15:27981	NTIS, PC A04/MF A01 - GPO; OSTI; INIS		TI90009572	
0386-Digest-5-Rev.5	15:27982	NTIS, PC A99/MF A01 - GPO; OSTI; INIS		TI90009547	

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0540-Vol.2-No.12	15:27983	NTIS, PC A11/MF A01 - GPO; OSTI; INIS		TI90009979	
0750-Vol.30-No.6	15:27984	NTIS, PC A06/MF A01 - GPO; OSTI; INIS		TI90009869	
0750-Vol.31-No.1	15:27985	NTIS, PC A07/MF A01 - GPO; OSTI; INIS		TI90009952	
1266-Vol.4	15:28066	NTIS, PC A04/MF A01 - GPO; OSTI; INIS		TI90009951	
1333-FINAL	15:28067	NTIS, PC A06/MF A01 - GPO; OSTI; INIS		TI90009517	
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0108	15:27986	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90009347	
NUREG/CR–					
2000-Vol.9-No.2	15:27987	NTIS, PC A06/MF A01; OSTI; INIS		TI90008977	
4691-Vol.1	15:28015	NTIS, PC E10/MF E01 - GPO; OSTI; INIS		TI90009797	
4882	15:28068	NTIS, PC A07/MF A01 - GPO; OSTI; INIS		TI90009516	
5001	15:27699	NTIS, PC A07/MF A01 - GPO; OSTI; INIS		TI90009922	
5393	15:27700	NTIS, PC A07/MF A01 - GPO; OSTI; INIS		TI90009543	
5438	15:28069	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90009923	
5463	15:27701	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90009582	
5493	15:28001	NTIS, PC A15/MF A01 - GPO; OSTI; INIS		TI90009329	
5494	15:28002	NTIS, PC A10/MF A01 - GPO; OSTI; INIS		TI90009330	
5517	15:27702	NTIS, PC A11/MF A01 - GPO; OSTI; INIS		TI90009792	
5540	15:28911	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90009928	
5547	15:27703	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90010075	
NUREG/IA–					
0021	15:28070	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI90009567	
0030	15:28071	NTIS, PC A05/MF A01 - GPO; OSTI; INIS		TI90009898	
0031	15:28072	NTIS, PC A08/MF A01 - GPO; OSTI; INIS		TI90009897	
0032	15:28073	NTIS, PC A09/MF A01 - GPO; OSTI; INIS		TI90009896	
OCS/MMS–					
88/0005	15:27572	*See* PB–90-164393/XAB			
OEFZS–					
4515	15:29179	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624599	
4517	15:27772	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624703	
4524	15:28722	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90624854	
OEFZS-A–					
1570	15:28647	the Austrian Research Centre Seibersdorf, A-2444 Seibersdorf (Austria)			
OPEC–					
90009426	15:27560	NTIS (US Sales Only), PC A03/MF A01; OSTI; Organization of the Petroleum Exporting Countries, Obere Donaustrasse 93, A-1020, Vienna, Austria		DE90009426	
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7	15:29895	NTIS (US Sales Only), PC A03/MF A01		DE90770715	
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6589	15:27701	*See* NUREG/CR–5463			
6602	15:29070	NTIS, PC A12/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007969	PC-402
6614	15:29146	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010214	MF-407
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31	15:28997	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007993	MF-402
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1120	15:27993	NTIS (US Sales Only), PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009444	
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200-Vol.9-No.2	15:27987	*See* NUREG/CR–2000-Vol.9-No.2			

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ORNL/Sub--					
7685/1-T23	15:29854	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007967	
86-SA094/4	15:27705	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010236	PC-513; PC-812
86-SA094/5	15:27706	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010226	PC-513; PC-812
86-SA094/7	15:27707	NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010227	PC-513; PC-812
86-SA094/8	15:27708	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90010222	PC-812; PC-513
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11534	15:29932	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009988	MF-400
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426	15:28131	*See* PB--90-159534/XAB			
OY/PSTL-TIED--					
66	15:27511	NTIS (US Sales Only), PC A03/MF A01		DE90770714	
PATENTS-US A--					
4876080/A/	15:27791				
4875467/A/	15:27861				
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4888522/A/	15:28594				
4891124/A/	15:28672				
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90-123159/XAB	15:28754	NTIS, PC A06/MF A01			
90-132564/XAB	15:29231	NTIS, PC A07/MF A01			
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90-153701/XAB	15:29074	NTIS, PC A05/MF A01			
90-153727/XAB	15:29075	NTIS, PC A07/MF A01			
90-153768/XAB	15:29076	NTIS, PC A07/MF A01			

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90-153776/XAB	15:29233	NTIS, PC A03/MF A01			
90-153800/XAB	15:29234	NTIS, PC A02/MF A01			
90-153842/XAB	15:28281	NTIS, PC A05/MF A01			
90-154287/XAB	15:27516	NTIS, PC EE05/MF E05			
90-154337/XAB	15:29897	NTIS, PC EE04/MF E04			
90-154436/XAB	15:29898	NTIS, PC EE04/MF E04			
90-154451/XAB	15:29899	NTIS, PC EE05/MF E05			
90-154592/XAB	15:29000	NTIS, PC A12/MF A02			
90-154709/XAB	15:29235	NTIS, PC A02/MF A01			
90-154832/XAB	15:28320	NTIS, PC EE99/MF E99			
90-154840/XAB	15:28321	NTIS, PC A08/MF A01			
90-154857/XAB	15:28322	NTIS, PC A07/MF A01			
90-154865/XAB	15:28323	NTIS, PC A14/MF A02			
90-154873/XAB	15:28324	NTIS, PC A06/MF A01			
90-154881/XAB	15:28325	NTIS, PC A22/MF A03			
90-154899/XAB	15:28326	NTIS, PC A08/MF A01			
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90-155144/XAB	15:29900	NTIS, PC EE04/MF E04			
90-155227/XAB	15:29901	NTIS, PC EE05/MF E05			
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90-155599/XAB	15:28130	NTIS, PC A04/MF A01			
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90-155631/XAB	15:29078	NTIS, PC A03/MF A01			
90-155649/XAB	15:29079	NTIS, PC A03/MF A01			
90-155656/XAB	15:29080	NTIS, PC A04/MF A01			
90-155672/XAB	15:27496	NTIS, PC EE99/MF E99			
90-155680/XAB	15:27497	NTIS, PC A09/MF A02			
90-155698/XAB	15:27498	NTIS, PC A07/MF A01			
90-155706/XAB	15:27499	NTIS, PC A12/MF A02			
90-155714/XAB	15:27500	NTIS, PC A12/MF A02			
90-155722/XAB	15:27501	NTIS, PC A15/MF A02			
90-155896/XAB	15:29236	NTIS, PC A02/MF A01			
90-155904/XAB	15:29237	NTIS, PC A03/MF A01			
90-155920/XAB	15:29238	NTIS, PC A02/MF A01			
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90-155953/XAB	15:29240	NTIS, PC A03/MF A01			
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90-157082/XAB	15:27517	NTIS, PC A10/MF A02			
90-157108/XAB	15:29001	NTIS, PC A03/MF A01			
90-157132/XAB	15:27479	NTIS, PC A03/MF A01			
90-157207/XAB	15:29902	NTIS, PC EE06/MF E06			
90-157504/XAB	15:29081	NTIS, PC A04/MF A01			
90-157512/XAB	15:29002	NTIS, PC A05/MF A01			
90-157801/XAB	15:27457	NTIS, PC A05/MF A01			
90-158395/XAB	15:27458	NTIS, PC A04/MF A01			
90-158411/XAB	15:27459	NTIS, PC A05/MF A01			
90-158908/XAB	15:27617	NTIS, PC A08/MF A01			
90-159054/XAB	15:27468	NTIS, PC A06/MF A01			
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90-159112/XAB	15:29003	NTIS, PC A02/MF A01			
90-159153/XAB	15:28196	NTIS, PC EE99/MF E99			
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90-159187/XAB	15:28199	NTIS, PC A11/MF A02			
90-159195/XAB	15:28200	NTIS, PC A10/MF A02			
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90-159393/XAB	15:29082	NTIS, PC A03/MF A01			
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90-159534/XAB	15:28131	NTIS, PC A08/MF A01			
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90-159625/XAB	15:27850	NTIS, PC A03/MF A01			
90-159666/XAB	15:28328	NTIS, PC EE99/MF E99			
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90-159708/XAB	15:28330	NTIS, PC A06/MF A01			
90-159732/XAB	15:27612	NTIS, PC A07/MF A01			
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90-159799/XAB	15:27613	NTIS, PC A21/MF A03			
90-159807/XAB	15:29083	NTIS, PC A18/MF A03			
90-159815/XAB	15:27793	NTIS, PC A03/MF A01			

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90-159823/XAB	15:29903	NTIS, PC A05/MF A01			
90-160003/XAB	15:29004	NTIS, PC A08/MF A01			
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90-160052/XAB	15:27581	NTIS, PC A06/MF A01			
90-160060/XAB	15:27635	NTIS, PC A04/MF A01			
90-160136/XAB	15:27514	NTIS, PC A04/MF A01			
90-160466/XAB	15:27588	NTIS, PC A08/MF A01			
90-160714/XAB	15:27460	NTIS, PC A06/MF A01			
90-160722/XAB	15:29084	NTIS, PC A05/MF A01			
90-160748/XAB	15:27446	NTIS, PC A06/MF A01			
90-160771/XAB	15:29085	NTIS, PC A04/MF A01			
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90-160961/XAB	15:29086	NTIS, PC A08/MF A01			
90-160995/XAB	15:29087	NTIS, PC A10/MF A02			
90-161001/XAB	15:28331	NTIS, PC A03/MF A01			
90-161068/XAB	15:29005	NTIS, PC A04/MF A01			
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90-161324/XAB	15:29263	NTIS, PC A03/MF A01			
90-161357/XAB	15:27461	NTIS, PC A03/MF A01			
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90-161563/XAB	15:28253	NTIS, PC A05/MF A01			
90-161837/XAB	15:29006	NTIS, PC A03/MF A01			
90-161845/XAB	15:29007	NTIS, PC A03/MF A01			
90-161852/XAB	15:29241	NTIS, PC A03/MF A01			
90-161928/XAB	15:27948	NTIS, PC A08/MF A01			
90-162157/XAB	15:28218	NTIS, PC A03/MF A01			
90-162173/XAB	15:27614	NTIS, PC A03/MF A01			
90-162199/XAB	15:27589	NTIS, PC A06/MF A01			
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90-162231/XAB	15:29088	NTIS, PC A11/MF A02			
90-162447/XAB	15:29008	NTIS, PC A03/MF A01			
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90-164542/XAB	15:29011	NTIS, PC A03/MF A01			
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90-165101/XAB	15:28166	NTIS, PC A02/MF A01			

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90-165564/XAB	15:29100	NTIS, PC A03/MF A01			
90-165978/XAB	15:28282	NTIS, PC A06/MF A01			
90-166091/XAB	15:28254	NTIS, PC A07/MF A01			
90-166109/XAB	15:27431	NTIS, PC A05/MF A01			
90-167206/XAB	15:27582	NTIS, PC A10/MF A02			
90-167214/XAB	15:27583	NTIS, PC A03/MF A01			
90-167222/XAB	15:27584	NTIS, PC A04/MF A01			
90-167230/XAB	15:27432	NTIS, PC A03/MF A01			
90-167248/XAB	15:27590	NTIS, PC A07/MF A01			
90-167263/XAB	15:28255	NTIS, PC A07/MF A01			
90-167271/XAB	15:27615	NTIS, PC A16/MF A02			
90-167289/XAB	15:27616	NTIS, PC A16/MF A02			
90-167297/XAB	15:27585	NTIS, PC A08/MF A01			
90-167354/XAB	15:27448	NTIS, PC A07/MF A01			
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90-167628/XAB	15:27636	NTIS, PC A08/MF A01			
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90-167750/XAB	15:27466	NTIS, PC A14/MF A02			
90-167784/XAB	15:27524	NTIS, PC A11/MF A02			
90-168030/XAB	15:29013	NTIS, PC A05/MF A01			
90-168238/XAB	15:27591	NTIS, PC A08/MF A01			
90-168246/XAB	15:27644	NTIS, PC A05/MF A01			
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90-168584/XAB	15:28132	NTIS, PC A07/MF A01			
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7276	15:28911	*See* NUREG/CR–5540			
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7289	15:27846	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008204	MF-600
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7405	15:29168	*See* AD-A–216921/7/XAB			
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7407	15:28363	*See* AD-A–216865/6/XAB			
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2809	15:28121	NTIS (US Sales Only), PC A03/MF A01		DE90770670	
2814	15:27881	NTIS (US Sales Only), PC A03/MF A01		DE90770668	
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89-2268C	15:27728	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005953	MF-721
89-2282C	15:27729	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005427	MF-721
89-2313C	15:28112	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009333	
89-2314C	15:27531	NTIS, PC A02/MF A01 - OSTI		DE90008344	MF-706
89-2322	15:27730	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90004163	MF-802
89-2347C	15:27731	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008461	MF-814
89-2359C	15:27732	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009532	MF-814
89-2382C	15:28970	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009511	MF-700
89-2383C	15:29909	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009323	MF-706
89-2425C	15:28759	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90002904	MF-706
89-2446C	15:27733	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007214	MF-814
89-2505C	15:28075	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008952	MF-706
89-2567C	15:28113	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009282	MF-706
89-2617C	15:28760	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007689	MF-706
89-2666C	15:28705	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90002989	MF-706
89-2730C	15:28761	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007686	MF-706
89-2813C	15:29933	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009971	MF-705

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
89-2913C	15:29277	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005195	MF-703
89-2918C	15:29581	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009833	MF-705
89-3060	15:27702	*See* NUREG/CR–5517			
89-3134C	15:28706	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005237	MF-706
89-7067	15:27734	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010245	MF-721
90-0050C	15:28958	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009571	MF-706
90-0081C	15:28762	NTIS, PC A02/MF A01 - OSTI		DE90005316	MF-706
90-0099C	15:28707	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006044	MF-706
90-0183	15:27859	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010243	MF-235
90-0202	15:29355	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90008203	MF-410
90-0223C	15:28708	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009512	MF-706
90-0249	15:29910	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010244	MF-705
90-0507C	15:28548	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008500	MF-704
90-0534C	15:28731	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007500	MF-706
90-0541C	15:28549	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007681	MF-704
90-0608C	15:28550	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009509	MF-706
90-0613C	15:28551	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009508	MF-706; MF-705
90-0818C	15:28650	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009570	MF-401
90-0890C	15:28552	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009332	MF-270
90-0906C	15:28959	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009320	MF-706
90-1105C	15:27646	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009835	MF-123
90-7026	15:27853	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010242	MF-274
90-8201	15:28283	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007934	MF-706
SC/ORC–					
AF88-05	15:28360	PC Ontario. Ministry of Transportation. Transportation Technology and Energy Branch, 1201 Wilson Ave., Downsview, ON, CAN M3M 1J8; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: PC PRICES UPON REQUEST; MF $10 CAN			
SCC–					
25(81-66)	15:28261	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
SCIENTIFIC–					
1	15:29335	*See* AD-A–216440/8/XAB			
SEG–					
CE02905	15:28126	Southam Energy Group, 300-999 Eighth St. S.W., Calgary, AB, CAN T2R 1N7. Prices: $197.00 CAN			
SEMR–					
11	15:28336	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
SERI/PR–					
215-3607	15:27848	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000302	MF-233; MF-234
SERI/TP–					
211-3643	15:27854	NTIS, PC A13/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000318	MF-270
260-3674	15:28122	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000322	MF-233
SGD–					
542-PT-2	15:29329	*See* PB–90-148677/XAB			
SHEC–					
CE02959	15:27844	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. Prices: $0.34 CAN per page, $3.40 minimum			
SIEMENS-KWU-UB–					
414/88/007	15:28297	Siemens AG Unternehmensbereich KWU, Offenbach am Main (Germany, F.R.)			
414/89/007	15:27660	NTIS (US Sales Only), PC A03/MF A01		DE90780160	
414/89/010	15:27957	NTIS (US Sales Only), PC A04/MF A01		DE90780161	
414/89/011	15:27669	NTIS (US Sales Only), PC A06/MF A01		DE90780162	
414/89/013	15:27558	NTIS (US Sales Only), PC A06/MF A01		DE90780163	
SIS–					
1989:3	15:29183	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90624533	

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SLU-IMB–					
40	15:27807	NTIS (US Sales Only), PC A10/MF A01		DE90770812	
SOL–					
90-5	15:29911	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009576	MF-405
SP–					
1988-46	15:27869	NTIS (US Sales Only), PC A03/MF A01		DE90770872	
SPIRE-QR–					
10120-02	15:27849	*See* AD-A–216857/3/XAB			
SRDP–					
R158	15:27666	*See* DNE-R–15			
SSI–					
89-02	15:28134	NTIS (US Sales Only), PC A03/MF A01		DE90770800	
SSS-TR–					
89-10755	15:28965	*See* AD-A–216848/2/XAB			
ST–					
173/89	15:29179	*See* OEFZS–4515			
174/89	15:27772	*See* OEFZS–4517			
STEV–					
1989-R3	15:28210	NTIS (US Sales Only), PC A04/MF A01		DE90770867	
1989-R6	15:29020	NTIS (US Sales Only), PC A04/MF A01		DE90770765	
STEV-EO–					
89-16	15:27798	NTIS (US Sales Only), PC A04/MF A01		DE90770767	
89-17	15:27799	NTIS (US Sales Only), PC A04/MF A01		DE90770768	
89-18	15:27800	NTIS (US Sales Only), PC A04/MF A01		DE90770769	
STEV-FBT–					
89-47	15:29021	NTIS (US Sales Only), PC A03/MF A01		DE90770791	
89-48	15:27450	NTIS (US Sales Only), PC A04/MF A01		DE90770792	
89-49	15:28709	NTIS (US Sales Only), PC A03/MF A01		DE90770793	
89-50	15:27502	NTIS (US Sales Only), PC A03/MF A01		DE90770794	
89-51	15:27839	NTIS (US Sales Only), PC A04/MF A01		DE90770775	
90-2	15:27503	NTIS (US Sales Only), PC A03/MF A01		DE90770852	
STEV-FGT–					
90-1	15:28887	NTIS (US Sales Only), PC A03/MF A01		DE90770869	
90-3	15:27451	NTIS (US Sales Only), PC A03/MF A01		DE90770853	
STEV-FJV–					
90-1	15:28262	NTIS (US Sales Only), PC A05/MF A01		DE90770854	
90-2	15:28710	NTIS (US Sales Only), PC A03/MF A01		DE90770855	
STEV-GT–					
89-2	15:27872	NTIS (US Sales Only), PC A04/MF A01		DE90770770	
STEV-NGAS–					
89-1	15:27637	NTIS (US Sales Only), PC A05/MF A01		DE90770774	
STEV-NYEL–					
89-7	15:28219	NTIS (US Sales Only), PC A07/MF A01		DE90770773	
STEV-TB–					
89-4	15:27801	NTIS (US Sales Only), PC A09/MF A01		DE90770771	
89-6	15:28611	NTIS (US Sales Only), PC A03/MF A01		DE90770772	
STEV-TORV–					
90-1	15:28337	NTIS (US Sales Only), PC A03/MF A01		DE90770850	
STEV-VIND–					
90-1	15:27878	NTIS (US Sales Only), PC A03/MF A01		DE90770851	
STEV-VK–					
89-4	15:28338	NTIS (US Sales Only), PC A03/MF A01		DE90770847	
STU–					
86-3891	15:28299	NTIS (US Sales Only), PC A03/MF A01		DE90770865	
88-949	15:27504	NTIS (US Sales Only), PC A04/MF A01		DE90770766	
SV-UL–					
1989-39	15:28264	NTIS (US Sales Only), PC A03/MF A01		DE90770779	
1989-47	15:27891	NTIS (US Sales Only), PC A03/MF A01		DE90770780	
1989-51	15:29026	NTIS (US Sales Only), PC A03/MF A01		DE90770798	
1989-56	15:28265	NTIS (US Sales Only), PC A03/MF A01		DE90770781	
1989-58	15:28266	NTIS (US Sales Only), PC A03/MF A01		DE90770778	
89-52	15:28263	NTIS (US Sales Only), PC A03/MF A01		DE90770784	
SV-US–					
1989-33	15:27950	NTIS (US Sales Only), PC A13/MF A01		DE90770799	
1989-34	15:27792	NTIS (US Sales Only), PC A03/MF A01		DE90770783	
1989-37	15:28300	NTIS (US Sales Only), PC A03/MF A01		DE90770785	
1989-39	15:27857	NTIS (US Sales Only), PC A03/MF A01		DE90770782	
SV-UV–					
1989-31	15:27944	NTIS (US Sales Only), PC A04/MF A01		DE90770796	
1989-32	15:27951	NTIS (US Sales Only), PC A03/MF A01		DE90770797	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
SVF–					
351	15:29022	NTIS (US Sales Only), PC A06/MF A01		DE90770843	
353	15:29023	NTIS (US Sales Only), PC A04/MF A01		DE90770844	
354	15:29024	NTIS (US Sales Only), PC A04/MF A01		DE90770845	
355	15:28339	NTIS (US Sales Only), PC A04/MF A01		DE90770841	
356	15:28412	NTIS (US Sales Only), PC A05/MF A01		DE90770846	
358	15:29025	NTIS (US Sales Only), PC A04/MF A01		DE90770842	
TKK-KO/ET–					
38	15:27505	NTIS (US Sales Only), PC A06/MF A01		DE90770762	
TKK-KO/LVI–					
B25	15:28267	NTIS (US Sales Only), PC A06/MF A01		DE90770759	
TM–					
89/02	15:27516	*See* PB–90-154287/XAB			
TR–					
0089(4470-03)-1	15:29345	*See* AD-A–216599/1/XAB			
2	15:28745	*See* AD-A–216980/3/XAB			
4477-142-89	15:28260	*See* PB–90-171232/XAB			
4488-019-90	15:27491	*See* DOE/PC/89796–1			
81W-006	15:27514	*See* PB–90-160136/XAB			
TTI–					
2-10-85-484-10	15:28282	*See* PB–90-165978/XAB			
TTKK-RT–					
1989/1	15:28268	NTIS (US Sales Only), PC A03/MF A01		DE90770761	
TVA/ONR/LFR–					
81/12	15:27459	*See* PB–90-158411/XAB			
UBA-FB–					
89-30	15:28340	Copy held by UB/TIB Hannover			
UCID–					
21761	15:28553	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008186	MF-704
21869	15:27735	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009513	MF-721
UCRL–					
101107	15:27736	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009435	MF-814
101526	15:29278	NTIS, PC A02/MF A01 - OSTI		DE90008300	MF-703
101792	15:28763	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009541	MF-706
102052	15:29913	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009540	MF-705
102114	15:27737	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009408	MF-814
102124	15:29103	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009437	MF-700
102263-Rev.1	15:29914	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90005181	MF-405
102287	15:28687	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009405	MF-706
102467	15:28967	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009943	MF-706
102603	15:28554	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90006261	
102749	15:29934	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008321	MF-406
102777	15:28711	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009033	MF-706
102781	15:29104	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009578	MF-721
102784	15:28346	NTIS, PC A03/MF A01 - OSTI		DE90009474	MF-361
102790	15:29105	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009580	MF-721
102857	15:28102	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008319	MF-707
102859	15:29106	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009577	MF-721
102872	15:29915	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007651	MF-705
102992	15:29602	NTIS, PC A; GPO Dep.	E 1.99:	DE90008723	
21008-Vol.4-Pt.2	15:29102	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009942	
21109	15:28966	NTIS, PC A18/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009440	
21203-Vol.2	15:29811	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010120	MF-712
21237	15:28964	NTIS, PC A04/MF A01 - OSTI		DE90009529	MF-706
21296	15:29356	NTIS, PC A03/MF A01 - OSTI		DE90009528	MF-706
50021-87	15:29812	NTIS, PC A99/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008198	PC-712; PC-732
50400-Vol.6-Rev.4-Pt.A	15:29514	NTIS, PC A16/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010470	MF-700
50400-Vol.6-Rev.4-Pt.B	15:29515	NTIS, PC A20/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010469	MF-700
52000-90-1/2	15:29912	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010155	PC-700
53944	15:28973	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008185	PC-700
99432	15:28413	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009949	MF-706
UCRL-CR–					
103145	15:28555	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009533	MF-706
103211	15:29813	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009539	MF-712
103232	15:29027	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009478	MF-700
103260	15:28414	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009534	MF-706
103293	15:28764	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009537	MF-700
103294	15:29582	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009476	MF-700

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
103296	15:29357	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009535	MF-700
103297	15:29583	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009536	MF-700
103371	15:28765	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009514	MF-712
103380	15:29358	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009477	MF-700
UCRL-ID–					
103198	15:29377	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008188	MF-705
103207	15:29603	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90010231	MF-700
103424	15:29359	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008190	MF-700
103499	15:29279	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008189	MF-703
UCRL-JC–					
103107	15:28968	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009944	
103143	15:29916	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009920	MF-705
103166	15:29028	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009434	MF-402; MF-412
103167	15:28651	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009579	MF-702
103243	15:29378	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009186	MF-705; MF-701
103243-Rev.1	15:28726	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009290	MF-701
103270	15:29379	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009948	MF-705
103312	15:28712	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009947	MF-705
103338	15:28766	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009945	MF-712
103348	15:29333	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009946	MF-700
UCRL-MA–					
103419	15:29917	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009955	MF-705
UIUC-HEPG–					
90-56	15:29449	NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90009954	MF-414
UJF–					
01/89	15:29537	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90623952	
UJV–					
8682-V	15:29851	NTIS (US Sales Only), PC A04/MF A01; OSTI; INIS		DE90625058	
UKC/COMPUTINGLAB–					
63	15:29897	*See* PB–90-154337/XAB			
USAFSAM-JA–					
88-67	15:29261	*See* AD-A–216869/8/XAB			
USDA/AER–					
627	15:28148	*See* PB–90-167453/XAB			
USDA/AIB–					
581	15:27850	*See* PB–90-159625/XAB			
UTRCN-G–					
18	15:29852	NTIS (US Sales Only), PC A16/MF A01		DE90777886	
UWThPh–					
1989-35	15:29496	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623404	
1989-40	15:29475	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623710	
1989-41	15:29476	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623690	
1989-43	15:29477	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623738	
1989-44	15:29450	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623761	
1989-46	15:29497	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623405	
1989-47	15:29604	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623376	
1989-49	15:29605	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623377	
1989-51	15:29606	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623378	
1989-52	15:29607	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623379	
1989-54	15:29478	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623739	
1989-55	15:29479	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623740	
1989-56	15:29608	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623388	
1989-59	15:29609	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623389	

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1989-64	15:29480	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623711	
1989-65	15:29481	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623691	
1989-66	15:29498	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623406	
1989-67	15:29499	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623407	
1989-68	15:29610	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623380	
1989-70	15:29611	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623381	
1989-71	15:29461	*See* HEPHY/PUB–527			
1989-73	15:29500	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623408	
1989-75	15:29612	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623382	
1989-76	15:29501	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623409	
1990-1	15:29613	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623390	
1990-5	15:29614	NTIS (US Sales Only), PC A02/MF A01; OSTI; INIS		DE90623383	
1990-7	15:29615	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623384	
1990-9	15:29482	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE90623741	
VTT-PUB–					
53	15:27506	NTIS (US Sales Only), PC A03/MF A01		DE90770728	
54	15:28767	NTIS (US Sales Only), PC A05/MF A01		DE90770764	
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1022	15:28270	NTIS (US Sales Only), PC A04/MF A01		DE90770745	
1053	15:28732	NTIS (US Sales Only), PC A03/MF A01		DE90770750	
1058	15:28309	NTIS (US Sales Only), PC A03/MF A01		DE90770746	
1059	15:28733	NTIS (US Sales Only), PC A03/MF A01		DE90770751	
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1063	15:28271	NTIS (US Sales Only), PC A05/MF A01		DE90770753	
1066	15:28182	NTIS (US Sales Only), PC A07/MF A01		DE90770756	
1069	15:28743	NTIS (US Sales Only), PC A04/MF A01		DE90770754	
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640	15:27434	NTIS (US Sales Only), PC A07/MF A01		DE90770748	
642	15:28310	NTIS (US Sales Only), PC A03/MF A01		DE90770733	
644	15:28273	NTIS (US Sales Only), PC A06/MF A01		DE90770727	
649	15:28311	NTIS (US Sales Only), PC A03/MF A01		DE90770726	
654	15:27937	NTIS (US Sales Only), PC A03/MF A01		DE90770749	
663	15:29030	NTIS (US Sales Only), PC A05/MF A01		DE90770755	
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WGL-MLR–					
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0300	15:27738	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008209	MF-902
0324	15:27739	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008208	MF-902
0331	15:27740	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008200	MF-721
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0475	15:28027	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90008386	MF-520
0560	15:27741	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009628	MF-721
0683	15:28028	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90007023	MF-530
0693	15:29814	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007822	MF-504
0741	15:28029	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90007819	MF-520
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0071	15:28017	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009489	MF-700

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0407	15:28019	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009486	MF-700
0457	15:28079	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009485	MF-700
0463	15:27744	NTIS, PC A11/MF A01 - OSTI		DE90009501	MF-721
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89-1438	15:28727	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009129	MF-706
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89-955	15:27746	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90009264	MF-721

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